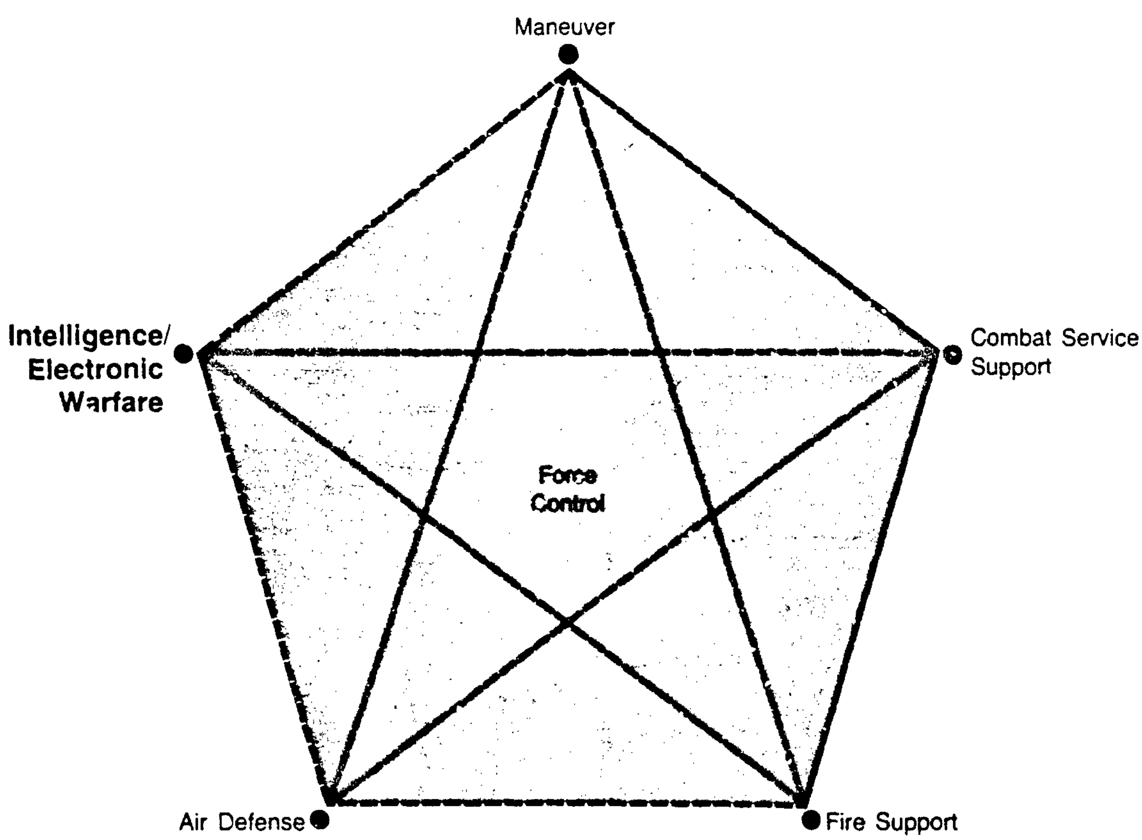
IEW Functional Area Model Requirements Definition



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IEW Functional Area Model Requirements Definition

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ABSTRACT

This document addresses user requirements, model representation requirements, and required IEW process descriptions relating to an IEW functional area model. In addition, it describes the results of an analysis of the requirements, and makes recommendations concerning a model hierarchy fulfilling them.

This work was done in support of the Army Model Improvement Program (AMIP), specifically to provide a direction for the development of an IEW Functional Area Model from the Corps/Division Evaluation Model (CORDIVEM) foundation.

TABLE OF CONTENTS

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Concluded)

LIST OF FIGURES AND TABLES

1.0 INTRODUCTION

This report sets forth user requirements and model objectives for an Intelligence and Electronic Warfare (IEW) Functional Area Model consistent with the Army Model Improvement Program (AMIP) family of Army models. It draws heavily on previous MITRE support to the AMIP Management Office (AMMO) regarding the Functional Area Representation Objectives (FAROs) for the Corps/Division Evaluation (CORDIVEM)* Model, and close coordination with both the IEW and modeling communities. (See references 23 through 38.)

1.1 Background

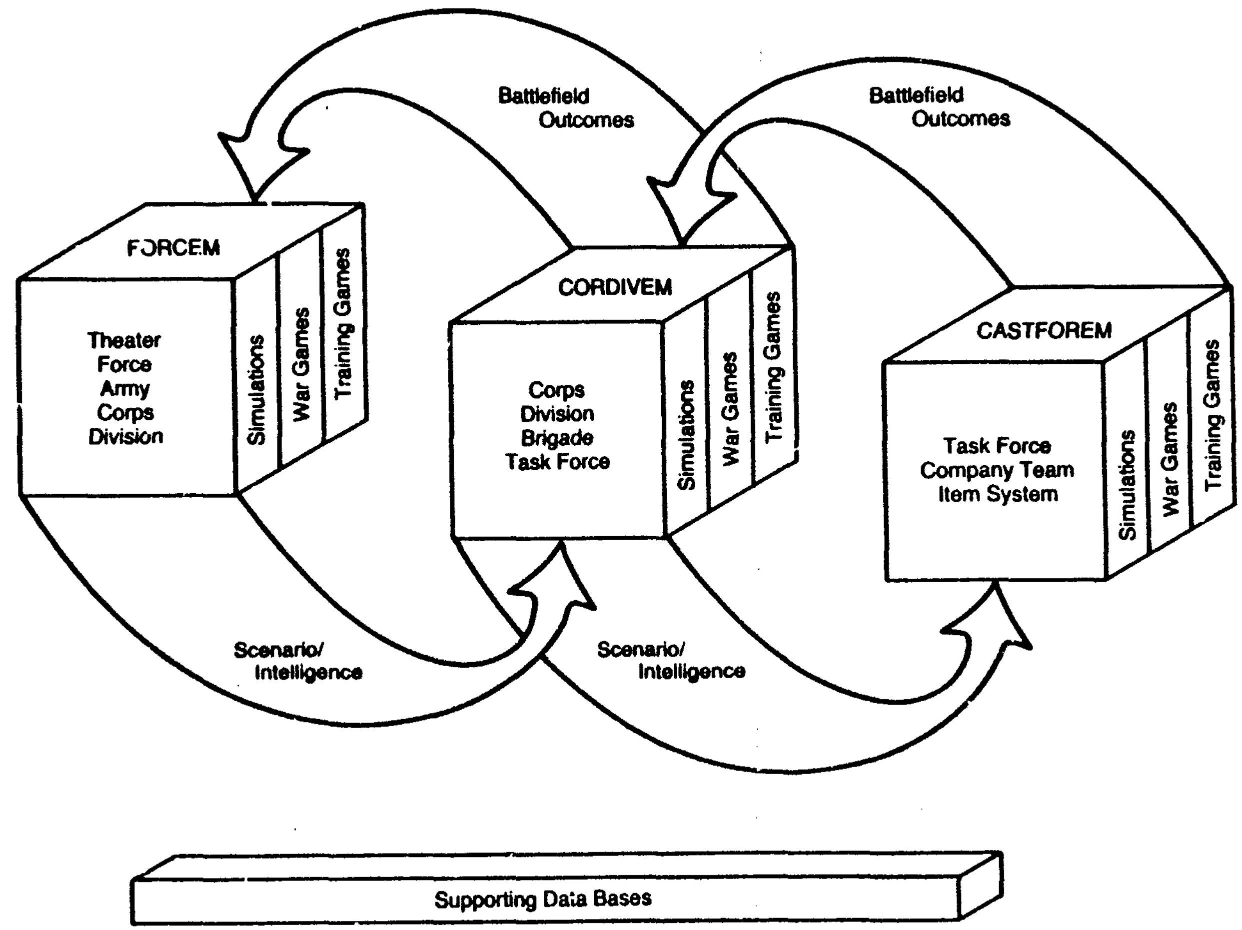
In 1978 the Army conducted a review of its analysis resources, organizations and procedures for the purpose of making specific recommendations for improvements. One of the recommendations made by the study and subsequently approved by the Army was that the development and implementation of a family of structured combat and support models be undertaken. This evolved into what is now called the Army Model Improvement Program (AMIP).

The AMIP Management Office (AMMO) was created in April 1980 with the primary mission of centrally managing the development of a hierarchical set of Army models. The executive agency responsible for direction, coordination and completion of AMIP efforts is the Training and Doctrine Command (TRADOC). Overall guidance for the program at Department of the Army level is provided by the Army Models Committee.

The AMIP hierarchical concept has three generic combat models and supporting data bases as its principal components (Figure 1-1). The battalion-level model is the Combined Arms and Support Task Force Evaluation Model (CASTFOREM) being developed by the TRADOC Systems Analysis Activity (TRASANA). The corps/division level model is the Corps/Division Evaluation

* Throughout this paper the terms CORDIVEM, FORCEM and CASTFOREM will be used to describe generic models at each of their respective levels, rather than any particular model presently in development.

Figure 1-1
The AMIP Concept



Model (CORDIVEM) in development at the Combined Arms Operations Research Activity (CAORA). The force-level (above corps) model is the Force Evaluation Model (FORCEM) in development at the Concepts Analysis Agency (CAA). The AMMO also has overall managerial responsibility for the development of the supporting data bases. Each of the models simulates the various aspects of combined arms operations, combat support and combat service support. It is envisioned that there will be three principal versions of each of the models: a fully-automated combat simulation, an interactive wargame, and a training version.

In addition to these three echelon-related models, the Army employs models designed to simulate specific functional area disciplines, such as IEW, fire support, air defense and logistics. The AMMO resolved to integrate the disparate functional area model development efforts under a broad management plan that would ensure their compatibility with the three hierarchy models. In this fashion, an IEW model would simulate IEW functions with more granularity to support functional area evaluations, and would provide aggregated performance data for use in the FORCEM and CORDIVEM simulations, thereby reducing the degree of complexity required in those models.

During 1981, MITRE supplied Functional Area Representation Objectives (FAROs) for use in the generic CORDIVEM development effort. These covered the five major functional areas (maneuver control, fire support, air defense, intelligence/electronic warfare, combat service support) and the integrating force control area. In October 1982 the Army tasked MITRE to assist the Army Model Improvement Program (AMIP) Management Office (AMMO) in the definition of model requirements for an IEW Functional Area Model that would be consistent with the design objectives set forth for the Corps and Division Evaluation Model (CORDIVEM). The requirements were to relate not only to the analytical use of such a model, but also to training and testing applications.

1.2 Report Overview

Section 2 is a description of user requirements by application for an IEW model, and the assessment means required in order to allow the model to be responsive to the user needs. Section 3 describes model representation requirements for an IEW model, focusing on force control, IEW area, other functional areas, and the threat. Section 4 is a description of required IEW capabilities or processes. In section 5 the requirements are aggregated in an attempt to determine broad modeling constraints which indicate the type and number of models required to satisfy user requirements.

2.0 USER REQUIREMENTS

This section will discuss those characteristics that an IEW model should have in order to be of value to its users in the areas of studies and analysis, system testing and configuration, and training.

2.1 Studies and Analysis Support

One required capability of an IEW functional area model is to support studies and analysis of the IEW functions, evaluating alternative procedures and sensors/systems. The two study types to be discussed here are the IEW Mission Area Analysis (MAA), performed by the U.S. Army Intelligence Center and School (USAICS), and the Cost and Operational Effectiveness Analysis (COEA), performed by the TRADOC Systems Analysis Activity (TRASANA).

2.1.1 Mission Area Analysis (MAA)

In an MAA, current capabilities are compared to functional requirements, and shortfalls are identified. Then, methods are suggested for eliminating these shortfalls, such as alternative force structures, alternative training methods, alternative methods of deploying systems, sensor tradeoffs, or the acquisition of new systems.

2.1.1.1 Study Issues. An IEW model supporting an MAA will be required to assist the user in studying the effects of the IEW area at the force level, the functional area level, and the system/item level.

Force Level Study Issues. At the force level, the model should study what the force commander's intelligence needs are,[33] how the capability of the force to accomplish its mission in combat depends on the quality of IEW products from the system/procedure under consideration, and how the battle outcome is affected by changes in IEW procedures and/or force structures. There is also a need to study the effects of system tradeoffs across functional area lines, to answer such questions as "Is it better to augment a division with 10 VHF jammers or 10 tanks?"[33] These issues call for a two-sided combat simulation in which to test systems and procedures, both real and hypothetical, which would incorporate direct fire, air defense, electronic

warfare (EW), indirect fire, tactical air, combat intelligence, and Blue electronic countermeasures (ECM), as well as a flexible representation of IEW organizations and C^3.

Functional Area Level Study Issues. At the functional area level, the model should study how each procedure or alternative combination of systems will affect the performance of the IEW functional area as a whole. The user will need to know how alternative command and control procedures, sensor systems, and mixes of sensor types affect the errors and omissions in intelligence reports, the time required for issuing reports, and the success of friendly and enemy jamming missions. In addition, the user will need to study alternate ways of analyzing the information collected by sensors[33]. These issues will require the model to include a mechanism for representing sensor tasking, data collection, fusion/exploitation, and reporting, as well as the adverse effects of friendly jamming on friendly operations. The model should also take into account the corps' role in bringing together information from echelons above corps (EAC), other services, and national and allied systems.

The following paragraphs provide examples of study issues addressed by an MAA with the aid of an IEW functional area model in the IEW disciplines of situation development, target development, EW, and counterintelligence (CI).[12] The means of assessing the functional area's performance in each of these example study issues will be addressed in section 2.1.1.2, under Assessment Means.

- In situation development:
  - Are higher echelons (EAC, theater, national) able to provide a predetermined required percentage of their total intelligence requirements to corps and division commanders?
  - What are the minimum amounts of data, the types and accuracy of data, and the timeliness of data required by the commander in making decisions, such as predicting the enemy's main attack force area, and in reinforcing these decisions?[33]
  - What is the optimal configuration for the fusion center?[33]
- In target development:
  - Is the timeliness of command and control adequate?

- How well do corps and division IEW systems obtain information on threat helicopter activity?
- More generally, the ability to locate and target key enemy positions is critical to successful IEW operations. Therefore, a study issue is:

  How well do corps and division IEW systems locate and target key enemy positions?

- In EW:
  - Is the timeliness of command and control adequate, specifically in the area of SIGINT/EW interaction?
  - Are friendly jammers causing the necessary percentage of degradation of enemy communications nets/emitters for meeting jamming requirements?

  In CI (including operations security (OPSEC) support):

  Is the IEW system capable of monitoring a specified percentage of friendly communications in a 24-hour period?

System/Item Level Study Issues. At the system/item level, the model should allow studies of how performance of IEW functions is affected by the vulnerability, mobility and performance characteristics of a specific real or hypothetical item of equipment.

Sample study issues at this level are:

- Which is the most effective sensor/jammer system to use in a given situation?
- How many sensors of a given type are required to satisfy collection requirements?(33)

In performing these studies, the IEW functional area model will need detailed data from engineering models.

2.1.1.2 Assessment Means. In general, there are three levels of measures required by the study analysts of the model under consideration, corresponding to the three levels of requirements. The combat simulation is run to provide an environment in which the IEW system operates, and the assessment of that operation can be made at the force level, the functional area level, or the system/item level.

Force Level Assessment Means. The main question at this level is "How well does the force perform in this particular IEW configuration?" In order to answer this question, one needs to define the word "perform". Most directly it means fight or attack or defend, depending on the scenario. A common

measure of effectiveness (MOE) at this level is the movement of the forward edge of the battle area (FEBA), where the front line is plotted over time to the credit or debit of friendly forces. In the fluid battle concepts of the Airland 2000 battlefield, this MOE may not be useful and perhaps should be replaced or augmented by a measure that would allow for pockets of forces, i.e., percentage of key terrain features held by either side.(18) A related MOE is the prevention of enemy breakthrough, as measured by penetration times.

The loss exchange ratio is another force level measure dealing with relative force strengths over time. Cumulative friendly losses are related to cumulative enemy losses, either overall or in categories of specific interest such as armor, airpower, or personnel. A related MOE here is the enemy's residual combat effectiveness (RCE).

Force level measurements need to relate to the mission of the force, perhaps traceable directly to the operations order at the start of the simulation. An example of this type of traceability would be as follows:

The Blue force's mission is to gain objectives A, B, and C (key terrain features currently held by Red forces), while holding firm on the southern flanks (where FEBA movement is a good measurement of success), and incurring a minimal loss in armor vehicles and attack helicopters (key functional area loss measurements).

Faced with this mission, Blue may be willing to accept high losses in all sectors but the south, and in forces other than armor and attack helicopters, in order to gain the key terrain features indicated. By allowing the measures of force effectiveness to reflect the force missions, the simulation will be able to accurately measure success. Specific strategies may be evaluated in light of the IEW contribution to the overall battle, and the contribution of the IEW system to force success will be reflected in these overall measures.

Functional Area Level Assessment Means. In an IEW model, the IEW system includes not only equipment, but groups of equipment, procedures and personnel. The evaluation of the worth of specific elements of the IEW system, such as a new organization, requires measures tailored to a narrower

field of view than the force level measures mentioned above. In this functional area assessment, measures of performance (MOP's) are required to show the contribution of the components of IEW to the efficiency and accuracy of the whole IEW system; this efficiency and this accuracy in turn affect force effectiveness.

Measures can be devised to show the contribution of the particular IEW disciplines (situation development, target development, EW, CI) to force effectiveness by selecting key features of these disciplines and measuring their values over time. For example, situation development depends greatly on the timely delivery of collected enemy situation data to the analytical system. A key measure is then the total time elapsed from detection to the generation of reports by the fusion center for use by the force commander.

The paragraphs below refer to the previously mentioned functional area study issues and their examples. These paragraphs provide means of assessing the performance of the IEW functional area in each of the four disciplines and detail the modeling implications of these issues.

1) Situation Development - In addressing the situation development issue of whether higher echelons are providing enough intelligence (Section 2.1.1.1, page 6), an assessment means is the number of the commanders' intelligence requirements satisfied by higher echelon assets compared to their total requirements. This implies that the model must represent the kind and amount of intelligence available from EAC sources.

The issue of the type, minimum amount and timeliness of data required to determine the main attack is addressed by the accuracy and timeliness of the identification of the main attack force and area, given differing amounts and types of data with differing time delays.

The configuration of the fusion center can be evaluated by the amount of intelligence it produces, the amount of sensor data it successfully processes, and how well it meets the commander's need for timely, accurate, and complete intelligence.[33]

Other functional area assessment means for situation development include the following:

- Percentage of second echelon units and Operational Maneuver Groups (OMG) detected[38]
- SIGINT frequency coverage as a function of time
- Percentage of mobility corridors covered by moving target indicator (MTI) surveillance over time[38]
- Number of units detected, by type
- Average communications delay associated with tactical intel reports
- Accuracy of unit type identification
- Mean time between reportable event and correlated results reported as unit type
- Percentage of high payoff movers detected
- Percentage of high payoff emitters detected
- Percentage of high payoff fixed targets detected
- Detection rate — number of high payoff targets detected per unit of time
- Number of sensors of each type nonfunctional at a given time due to attrition or breakdown
- Perception of Red strength by Blue force

2) Target Development - The issue of the timeliness of command and control can be addressed by four measures: 1) the time it takes for an intercept operator to obtain SIGINT DF support; 2) the time it takes for an intercept operator to obtain SIGINT analytic feedback; 3) the time it takes for ELINT radar lines-of-bearing to produce a fix; and 4) the time it takes to cross-cue various sensor types.

In addressing the target development issue of how well the corps and division IEW systems obtain information on threat helicopter activity (Section 2.1.1.1), a means of assessment is the percentage of existing helicopter targets detected. This implies that the model must play enemy helicopters, as well as task collection assets against them.

The more general issue of how well key positions are located and targeted would be addressed by the percentage of key targets located (movers, emitters, and fixed targets), mean target location accuracy, and the percentage of targets engaged due to IEW detection.

3) EW - The issue of the timeliness of command and control in the interaction of SIGINT and EW can be decided by two measures: 1) the time it takes for intercept to cue a jammer, and 2) the time it takes to determine which jammer to use.

In addressing the EW issue of whether friendly jammers are causing sufficient degradation of enemy communications, a means of assessment is the percentage of degradation of enemy communications nets/emitters. This implies that the model must play friendly jammers and enemy communications nets/emitters.

Other functional area assessment means for EW include the following:

- Number of high payoff nets jammed compared to total number tasked
- Duration of jamming of enemy/friendly emitters
- Enemy/friendly mission delay
- Probability of unintentional jamming of friendly systems
- Mean tasking time

4) CI - In addressing the OPSEC support issue (within CI) of whether the IEW system can monitor a specific percentage of the friendly communications, a means of assessment would be the percentage of friendly communications monitored when factors such as equipment obsolescence, inefficient manual operations, and personnel shortfalls are considered. This implies that the model must represent such things as delays and inaccuracies caused by the use of outdated equipment, the lack of trained personnel, and/or the use of manual operations.

System/Item Level Assessment Means. At the lowest level, there is a need to quantify the contribution of specific pieces of equipment to the performance of the IEW functional area and the overall flow of battle.

In order to address the issue of which sensor/jammer system is most effective, the means of assessing a sensor system include the following:

- Probability of sensor detection
- Location error
- Number of targets detected
- Time from sensing to sensor report (system processing time)
- Communications times
- Tasking times
- Degradation of system performance when not fully operational; that is, when half of the system is relocating, or only a portion of the system, such as the all source analysis system (ASAS), is working, or a ground processor is moving
- Survivability

Means of assessing a jamming system are listed below:

- Probability of detection
- Time from intercept until jamming occurs
- Distribution of signal strength over time
- Probability of jamming enemy communications nets/ noncommunications emitters
- Number of high pay-off targets jammed per unit of time
- Tasking times
- Missions attempted/missions successfully completed
- Survivability

To address the issue of the number of a given sensor type to use, the assessment means is the number of the commander's intelligence requirements satisfied by various numbers of sensors of the given type.

2.1.2 Cost and Operational Effectiveness Analysis (COEA)

Another required capability of an IEW model is to support studies and analysis concerned with procurement of a specific IEW system, providing information to be used in making such decisions as what systems the Army should buy, in what quantities, and when. An example of this type of study is a system Cost and Operational Effectiveness Analysis (COEA).[1]

IEW model support of a system COEA is intended to provide information on the operational effectiveness of a particular system such as GUARDRAIL, ASAS, etc., measuring the system's contribution to the battle outcome. This is done by incorporating a simulation of the system into a combat simulation and analyzing the result of a run or series of runs. In addition, the model may be used to compare various versions of the system; for example, in testing the effectiveness of an ASAS it may be necessary to select the most effective alternative from a manual version, a semiautomated version, and a fully-automated version.

2.1.2.1 Study Issues. As in the case of an MAA, an IEW model supporting a system COEA will be required to assist the user in studying effects at the force level, the functional area level, and the system/item level. However, the COEA is intended to evaluate the effectiveness of a particular item of IEW equipment, in various versions and configurations, rather than of system mixes and IEW processes.

Force Level - At the force level, the IEW model must assist the analyst in studying such issues as the comparative combat effectiveness of the force without the system in question (baseline) and with the addition of the system, possibly in several versions. Another issue is the adequacy of organizational and operational concepts proposed for the system; that is, the degree to which the overall battle outcome is affected by changes in procedures and force structures, such as placing the Remotely Piloted Vehicle (RPV) platoon under the control of a different parent unit.[1]

Functional Area Level - At the functional area level, the user needs to study the effectiveness of the system and its alternatives in terms of their contributions to the functions of IEW. An example of such an issue is how the system alternatives affect the number of enemy targets detected and the number identified.

Another issue in some cases may be the system's effect on functional areas other than IEW. For example, since the RPV system is intended to be used primarily for artillery adjustment, a study issue is the system's effect on the ability of an artillery battalion to deliver fires.

System/Item Level - At the system level the model should assist the user in assessing the performance of system alternatives in terms of equipment characteristics. One issue will be to determine how sensitive the system's operational effectiveness is to variations in the essential characteristics of the system: what is the effect of increasing the range, for example, or of decreasing the field of view, and how do these changes affect the relationship of effectiveness to cost? Another issue for study will be the survivability of the alternative systems, including the impact of EW and Communications Security (COMSEC) threats, and the operational techniques and procedures that could be used to circumvent those threats. At this level of COEA study, as in an MAA, the IEW functional area model will require detailed sensor representations to allow accurate evaluations of competing system configurations.

2.1.2.2 Assessment Means. As in the case of an MAA, there are three levels of assessment means which an IEW model supporting a system COEA can furnish. These are force level, functional area level, and system level assessment means, and each addresses the corresponding level of example study issues.

Force Level Assessment Means. At the force level, the measures of effectiveness are concerned with how the systems affect the overall outcome of the battle. Some sample measures of effectiveness are:

- Time required to detect the commitment of Red second echelon divisions
- Time of penetration
- Ratio of Blue to Red forces in the sector
- Rate of FEBA movement, or percentage of key terrain held
- Status of friendly and enemy forces (the remaining fighting capability of friendly forces, the strength of enemy forces continuing to fight)
- Duration of the battle (time to breakthrough)

Functional Area Assessment Means. The study issues related to the effect of the system on the performance of the IEW functional area can be assessed by the total number of enemy target complexes detected and the number identified, both with and without the system alternatives being evaluated.

In the case of the RPV, its effects on the performance of the fire support functional area can be assessed by the total number of targets destroyed, the number of targets destroyed by range and type, and the number of rounds expended per target destroyed. Again, the figures would be given for the baseline IEW system and for the IEW system augmented by each of the variations of the RPV.

System/Item Level Assessme t Means. System COEA's depend on the ability to measure system performance and relate it to the success/failure of the simulated campaign as a basis for procurement/production decisions. The analytical model must therefore be able to track specific measures of system performance relating to the specific system under evaluation.

To assess the characteristics of the particular system being evaluated, the model should furnish, for example, the following data for each system alternative as results of a simulation run:

- Number of systems surviving after a given time, under various conditions of combat and implementation
- Percentage of performance degradation due to weather
- Time delays for processing and reporting
- Number of targets detected
- Target type identification ability
- Number of targets located with acceptable accuracy
- Operational range achieved for each alternative system

For example, an IEW model may be used to assess two versions of an airborne MTI system in support of a COEA. Of particular concern would be such measures as:

- Time on station
- Survivability of the platform

- Detection rate of the radar
- Saturation point of the radar
- Communications rate of the transmission means for target reporting
- Coverage (time/area)
- Range and resolution of the radar beam

The simulation must be able to accept new measures of performance at this level in order to be responsive to the needs of the analysis; the model measures will need to be tailored to support specific system COEA's.

2.1.3 Corps/Division Evaluation Model (CORDIVEM) Requirements

A detailed model of the IEW functional area, as well as other functional area models, will be needed to provide aggregated values to the systemic CORDIVEM, an analytical model to be developed by the Combined Arms Operations Research Activity (CAORA) at Ft. Leavenworth, Kansas. This IEW functional area model should portray all five functional areas (maneuver control, fire support, air defense, combat service support, and IEW), being more detailed than CORDIVEM in the IEW area and less detailed in the other four areas. The CAORA team currently producing the interactive version of CORDIVEM is looking to an IEW model for a methodology for representing IEW and Red sensors.[34]

2.2 System Testing Support

An IEW functional area model may be used as a tool for testing actual IEW systems under development, primarily processing centers, and for validating requested changes to software in fielded or soon-to-be-fielded IEW systems. This validation is currently performed by the USAICS TRADOC Combat Development Support Facility (CDSF), located at Ft. Huachuca, Arizona.

2.2.1 Developmental Testing

2.2.1.1 User Requirements. The chief requirement in the area of system testing is for a simulation which will provide intelligence messages to the system under test. This will involve:

- Simulation of threat activities against which the system will work
- Simulation speed sufficient to support real-time testing

- Message generation
- Proper message format, for example, Joint Interoperability of Tactical Command and Control Systems (JINTACCS) messages for The Battlefield Exploitation and Target Acquisition System (BETA)
- Satellite interface for remote users
- Output for evaluation of results
- Appropriate number of messages per hour sent to the system being tested - for example, the Tactical Simulator (TACSIM) was required to produce 4,000 reports per hour, resulting in 267 messages to BETA (1 message for every 15 reports).[16] The rate should be high enough to adequately test the system's ability to process messages.
- Messages which are realistic and meaningful in content. This depends on the quality of the simulation producing the messages, and can be checked by tracing the messages back to the simulated events which caused them.
- An acceptable percentage of the messages usable by the system (proper format, data types, etc.); format errors which are likely to be encountered in the real world simulated by the message generator
- An acceptable percentage of tasking messages from the systems actually carried out by the simulation and reflected in intelligence messages sent back to the system
- Appropriate data types for the system
- Sufficient number of communications lines for message traffic
- Audit trails for post-test validation of results (tracing messages back to simulated causative events and relating sensor output to combat activities)[17]
- Detailed sensor models
- Ability to respond to tasking messages from the system (for example, the ability to activate simulated COMINT sensors in response to a message from the system requesting COMINT)

All-Source-Analysis System (ASAS) - Specific Requirements - Specific simulation requirements for ASAS development are described below.[22]

The basic requirement is for a simulation of the ASAS itself (the ASAS Model) and a simulation of the environment, to include communications lines, other Command and Control Subordinate Subsystem (CCS^2) components, sensor systems, preprocessors, the battlefield, weather/terrain, enemy resources and capabilities, and the dynamic interaction over time between

these components (the Environment Model). In this discussion the Environment Model will be considered to correspond to an IEW functional area model.

These two models will assist two developers, the combat developer and the materiel developer, in testing during four stages of ASAS development - conceptual, validation and demonstration, full scale engineering development, and production and deployment. The materiel developer deals with the materiel system and conducts developmental testing (DT) to ascertain whether the engineering development process is complete and the system meets specifications. The combat developer, on the other hand, is concerned with such concepts as doctrine, organization, and employment, and plans and develops operational testing (OT) to evaluate such system characteristics as military utility and effectiveness.

Figure 2-1 depicts the requirements in each of these phases for the Environment Model.

2.2.1.2 Assessment Means. The means of assessing the performance of the system under test include the percentage of messages received which are processed by the system in a given time period, the percentage of enemy units correctly identified, the accuracy of the predicted attack sector, enemy strength in the attack sector, and the enemy's time of arrival in the attack sector.

The following measures of time delays will also be used in assessing the system's performance:(2)

- From external request to collection plan
- From collection plan to sensor tasking
- From tasking to detection
- From detection to mission evaluation and technical feedback
- From evaluation to response to request
- From commitment of second echelon to detection and confirmation
- From detection of targets to identification and location

Figure 2-1
Environmental Model Required Characteristics

	Characteristic					
Phase	Level of Model Detail	Time Keeping	Human Interaction	Scenario Operation	Enemy Doctrine	Military Granularity
Conceptual	Moderate	Compressed Time	Fully Automatic	Static	Prescribed	Div/Corp
Validation and Demonstration	Moderate to High	Compressed Time	Fully Automatic	Static	Prescribed	Various Levels
Full Scale Engineering Development	Full Detail Models or Real Items	Real Time	Semi Automatic	Static and Dynamic	Intelligent Gaming	Various Levels
Production and Deployment	Moderate to High	Real Time	Interactive	Dynamic	Intelligent Gaming	All Force Structure Levels

2.2.2 Post-Deployment Software Support

The CDSF has responsibility for post deployment software support. In this capacity, the CDSF validates and reviews proposed changes to the software employed in fielded and soon-to-be-fielded IEW systems, and passes its findings on to the Department of the Army Development & Research Command (DARCOM) for implementation.

2.2.2.1 User Requirements. The CDSF will need simulation support for two of its main functions: 1) testing alternative software algorithms to determine which should be used in a given IEW system, and 2) sensitivity analysis, to determine how proposed software changes to one system will affect other systems.

In order to carry out these functions, the CDSF will need:[35]

- A combat simulation which will provide realistic messages to the system — this need not be a two-sided simulation
- Code that duplicates the performance of each of the proposed alternative algorithms
- A model of the specific system — there should be both an engineering model, to accurately portray the performance of the system and an aggregated model, to provide results to models of other systems in order to show the effects of changes to one system on another.
- Item level simulation of processing techniques
- Audit trail for intermediate results

These requirements stipulate a highly resolved set of IEW system representations.

2.2.2.2 Assessment Means. The performance of alternative software techniques can be assessed by evaluating key performance characteristics relating to each alternative under review, and weighing the results. Intermediate measures are also required to show how combinations of systems perform in varying software configurations.

2.3 Training Support

2.3.1 Field Training Exercise (FTX) and Command Post Exercise (CPX) Support

An IEW model can assist in training exercises by providing a simulated combat environment in which intelligence analysts and decision makers can develop their skills, thus reducing the personnel and materiel resources required for a manual exercise, reducing costs, and eliminating the safety constraints necessary when real forces are used.

2.3.1.1 User Requirements

General requirements of an IEW model for supporting training exercises are listed below:

- As much automated support as practical to reduce the number of personnel required (due to cost considerations)
- Flexibility of configuration to support various training objectives
- Realistic interfaces between simulation and players (format, content, quality, timeliness)
- A mechanism to insure that player decisions affect the battle situation

More specific requirements (based chiefly on stated requirements for the TACSIM system)[16] may be grouped into four categories: 1) pre-exercise scenario development, 2) simulation modeling, 3) message handling, and 4) displays. Requirements for each of these categories are described below.

1) Pre-Exercise Scenario Development

- Automated support to avoid having to input each piece of scenario information[15]
- Faster-than-real-time playback to verify the scenario

2) Simulation Modeling

- Simulation speed sufficient for supporting real-time exercises
- Two-sided
- Resolution level which is able to accommodate user's scenario, from highest echelon units used to lowest — battalion level down to weapon system level
- Comprehensive suite of sensors
- Damage effects of employed weapons systems

- Ability to accept player input (new units, orders, combat rules)
- Logic to carry out orders (select weapons, routes, flight plans, etc.)
- Output with suitable form and frequency (unit locations, attrition, resource expenditure and resupply, countermeasures, air sorties, time of activities)
- Ability to accept controller input and override (change state variables, correct errors in data base, override player input)
- Audit trails for post-exercise validation of results—comparison of ground truth with messages on which players have based their decisions; a determination of how responsive the simulation was to player input
- Events modeled explicitly enough to trigger observables for detection by sensors, e.g., artillery fire detectable by counter battery sensors, or aircraft flights under Blue radar surveillance

3) Message Handling

- Sufficient message generation rate
- Appropriate format for the automated support tool used (such as for a BETA testbed)
- Event-driven message generation — report events as they happen, instead of summarizing events at regular intervals

4) Displays

- Display rules for fusion and the filtering of various types of sensor reports
- Graphic comparison of ground truth with battlefield as perceived by sensors

ASAS - Specific Requirements - The following paragraphs discuss what is required of an IEW model in a CPX designed to train system supervisors and commanders in the use of an ASAS.[22]

Because such decision makers must understand the associated doctrines and operational concepts, the model should include wargame and combat simulations which will show the effects of player decisions. This implies a need for dynamic scenario generation which reflects the interaction of sensor observation analysis, command decisions, battle conduct with an intelligent enemy, and further observation. In addition, a battlefield ground truth should be maintained which documents the effects of this interaction.

In order to portray this interaction, the model should represent combat, command structure, friendly and enemy forces, the effects of communications interfaces, lines, and switches, and the use of engineering models for sensors to obtain realistic sensor data streams.

2.3.1.2 Assessment Means

The effectiveness of the exercise can be measured by the same assessment means used for studies and analysis. Additional assessment means in the four previously discussed areas are outlined below[16].

1) Pre-Exercise Scenario Generation. The assessment means related to this function is the time required to generate the scenario with automated support versus the expected time required for manual generation.

2) Simulation Modeling

- Speed of simulation, status reports — did simulated events take place in real-time? Were players provided timely updates on unit locations, attrition, resupply requirements, etc.?
- Responsiveness — were player inputs reflected quickly and accurately in the simulation? Were player orders implemented smoothly without requiring specific detail from the player? For example, if the player orders an aerial surveillance of a particular area, could the simulation construct the detailed flight plan?

3) Message Handling

- Were the players given accurate messages on which they could base their decisions? (This is determined by post-exercise comparison of ground truth with generated messages.)
- Were messages provided with enough timeliness to allow the players to react to them and affect the simulation?

4) Displays

Are displays updated often enough to give the players an accurate picture of the battlefield as perceived by the sensors, as well as the current fusion and filtering rules?

2.3.2 School Training Support

An IEW functional area model may also be used to support the training of intelligence analysts. The type of training provided by the U.S. Army Intelligence Center and School (USAICS) has been used as the standard for generating user requirements.

2.3.2.1 User Requirements

An IEW model used to support classroom instruction of IEW procedures would be required to provide the following features:

- Simulation of threat events — a library of scenarios covering different combat situations, time periods, and geographical areas(35)
- Faster-than-real-time simulation
- Resolution level must be able to accommodate user's scenario from highest echelon units used to lowest — battalion level down to weapon system level.
- Comprehensive suite of sensors
- Ability to interactively vary the combination of sensors used (instructor or student)
- Graphic display of battlefield as perceived by sensors
- Low-level training module for intelligence preparation of the battlefield, collection management, sensor correlation and fusion, situation development, and target development
- Audit trails for post-exercise validation, i.e., comparison of ground truth with the messages on which students have based their decisions, a determination of how responsive the simulation was to student inputs, as well as intermediate results

2.3.2.2 Assessment Means

Basically, the requirement is to measure student performance in each of the IEW disciplines under examination. The effectiveness of the course of instruction of which the model is a part can be measured by these criteria:

- The procedural completeness of the student answers
- The ability of the student to support his conclusions with obtained or inferred facts
- The initiative of the student in the application of principles of military intelligence to new areas
- The student's familiarity with threat organizations, equipments, and tactics

2.4 Summary of User Requirements

Section 2 has discussed user requirements for an IEW functional area model in three broad application areas - studies and analysis, system testing, and training.

The major uses of the model in each of these application areas are summarized below:

- Studies and Analysis
  - MAA (identify IEW shortfalls, recommend solutions)
    - — evaluate alternative force structures
    - — evaluate alternative training methods
    - — evaluate alternative system deployment
    - — evaluate sensor tradeoffs
    - — evaluate new systems
  - COEA (determine operational effectiveness of IEW systems)
    - — measure system's contribution to combat
    - — evaluate alternative versions of the system
- System Testing
  - Developmental Testing
    - — provide intelligence messages to system under test
  - Software Support
    - — evaluate proposed software changes to IEW systems
- Training
  - Exercise training
    - — combat environment for training system supervisors and commanders
  - Classroom training of intelligence analysts

3.0 MODEL REPRESENTATION REQUIREMENTS

The planned approach of using the Corps/Division level model (CORDIVEM) as a foundation for the IEW model[14] has many impacts on the details relating to requirements for model resolution and process representation. The concept calls for a common battlefield environment, threat, and scenario for the two models, as well as a common representation of friendly forces. The scope differs significantly in the two models, however, because of the issues they are designed to address. CORDIVEM is a force level combat simulation and is designed to study force structure trade-offs and cross functional area evaluations. The IEW model, on the other hand, is conceived to be a tool for the detailed analysis of IEW-specific issues regarding IEW organizations, equipments, and tactics. Conceptually then, the IEW model will require a greater degree of granularity in both the IEW functional area and in the interface into that area from other functional areas. This section will describe the representation of those areas to be expanded in an IEW model formed from the CORDIVEM base. The organization employed here is consistent with Appendix IV of the CORDIVEM FAROs [11] dealing with the IEW functional area, and as a minimum meets the requirements detailed in Section 2 of this paper.

3.1 Standard Effects

This section concerns the effects of the interactions among threat units, the environment, and friendly units. The CORDIVEM IEW FARO[11] contains a detailed discussion of these effects, and to date there are no additional effects representations required that are specifically relevant to an IEW model. For the reader's reference, the categories of effects included in the CORDIVEM IEW FARO are shown in table 3-1.

Table 3-1

CORDIVEM IEW FARO EFFECTS

- Effect of Executing each capability
  - on the enemy
  - on the environment
  - on friendly forces/assets

- Combat effects on each capability
- Environmental effects on each capability
- Situational Factors relating to each capability
- Effects from other functional areas on each capability

3.2 Force Control

The following sections describe the relationship between the force control portion and the IEW portion of the IEW model. The force commander makes C^2 decisions concerning force employment using the knowledge of the enemy provided by the IEW system. He obtains intelligence by making requests for information to the IEW system. He has the overall responsibility for the deployment and employment of IEW systems, and he receives results in the form of intelligence reports.

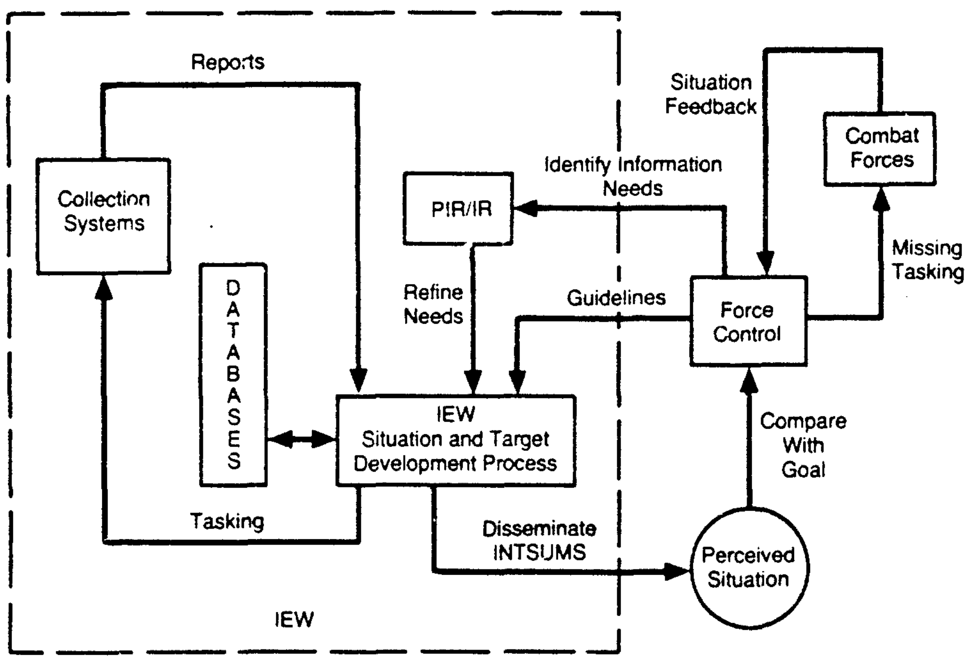
Based on the force C^2 representation objectives (FC^2RO) of the FARO's(11), this section will highlight those force control issues which are relevant to the IEW system.

The force control portion of the IEW model at each echelon must be able to direct the IEW situation development and target development efforts. The process of observing a battle and directing intelligence collection based on the scheme of maneuver is central to analyzing the effectiveness of the IEW system as a whole. Figure 3-1 depicts this process. The following sections will deal with identification of intelligence requirements, the development of guidelines for the use of IEW systems, and the reporting from IEW to force control in response to intelligence requests.

3.2.1 Requirements for IEW Support

Generally, the commander has derived a series of objectives from mission statements received from higher echelons. He then develops Priority Intelligence Requirements and Information Requirements (PIR/IR) that he requests of the IEW system. These are data items that will assist him in planning courses of action and battlefield monitoring. The force control portion of the model therefore must provide the IEW portion with specific and operationally relevant PIR/IR. Considerable effort remains in the IEW portion to decompose these PIR/IR first into critical indicators and then into operational collection requirements.

Figure 3-1
Requirements – Driven Collection



For example, one such PIR might be posed as the following question:

When, where, and in what strength will the enemy commit his second echelon forces?

To be able to answer this question, the IEW system needs to decompose it into the critical indicators which would indicate an answer. Some example critical indicators that follow from the above PIR are:

- Concentration of enemy artillery battalions in a localized area
- Concentration of enemy bridging and engineer units forward
- Heightened rate of enemy supply in the sector examined
- Indication of rapid, sustained movement in a localized area

To determine the values of these critical indicators, the IEW system needs to collect data concerning:

- Locations of enemy second echelon artillery, maneuver and engineer units
- Movement of enemy resupply elements
- Movement of enemy rear-area maneuver forces

3.2.2 IEW Guidance

The force commander's IEW assets are scarce, highly valuable, and vulnerable tools for his understanding of the ongoing battle. In addition to stating his information requirements, he will impose certain restrictions on the system that should be respected in an IEW model. Such restrictions may include curtailed flight paths, time limits on operations, prohibited areas of operation, or limited distribution of intelligence reports. The force control portion will need to be able to constrain the employment tactics of IEW systems, or conversely, to direct systems on unconventional and potentially more dangerous collection missions based on the perceived situation.

3.2.3 Comparison of Perceived State with the Goal

The force control element in the IEW Model must be able to compare the results of the IEW situation development process with the desired situation the force is trying to achieve. The results of this comparison will recommend further action by the force, and/or further collection missions for

IEW elements. Mechanisms should exist to allow for doctrinally-based situation evaluation rules to influence further actions of the force as a result of the IEW collection and fusion efforts.

3.3 IEW Functional Area Representation

The following paragraphs describe the command and control relationships, functional responsibilities and assets of the major IEW elements to be represented in an IEW model. Figure 3-2 shows an overview of the elements to be discussed in the following echelon-keyed outline. Each element is described in terms of its capabilities or the processes which it can perform. A fuller description of these processes can be found in Section 4. Refer to table 3-2 for a list of the IEW processes included.

3.3.1 Corps Echelon

3.3.1.1 Control Units

3.3.1.1.1 Corps Electronic Warfare Section (EWS)

EW Mission Planning and Tasking, EW Mission Assessment - The Corps EWS is primarily responsible for the implementation of the Corps G3 operations plans regarding EW operations. The EWS uses its own staff, supported by the G3 staff as required to plan, task and evaluate ESM and ECM operations[39].

Communications and Movement - The EWS relies on communication means (multichannel, RATT) and transportation provided to the All Source Analysis Center (ASAC) as part of the Corps Tactical Operations Center (CTOC).

3.3.1.1.2 Corps All Source Analysis Center (ASAC)

The Corps ASAC is an aggregation of IEW control elements within the CTOC. These elements are the Collection Management and Dissemination Section (CMDS), the All Source Production Section (ASPS), the Technical Control and Analysis Element (TCAE), the Field Artillery Intelligence Officer (FAIO), and the CI Analysis Section (refer to figure 3-3). Because its role is primarily one of a geographic center, the ASAC need not be explicitly modeled in an IEW functional area model.

Figure 3-2
Required IEW Elements

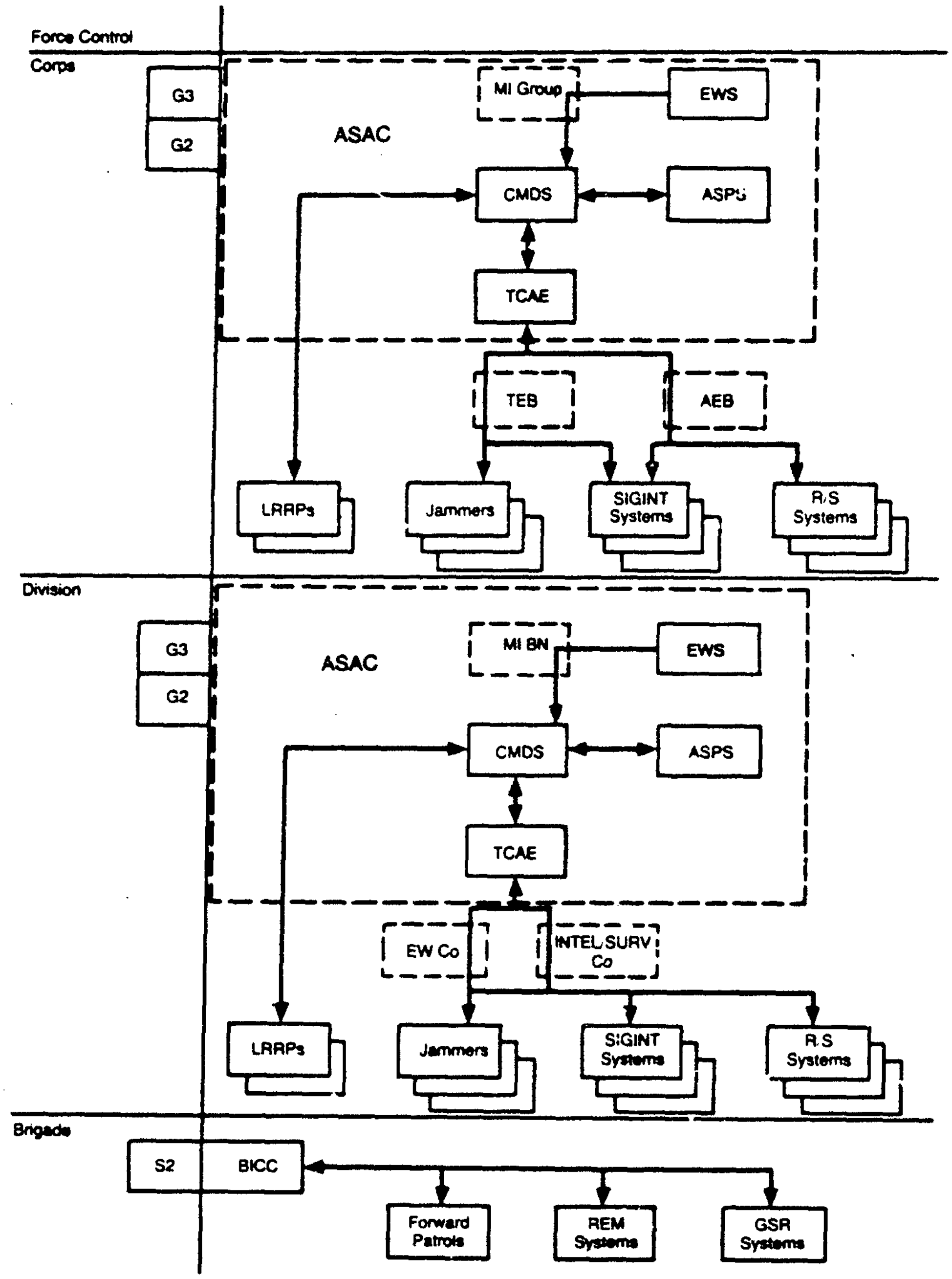


Table 3-2

IEW MODEL PROCESSES

- Situation and Target Development
  - Intelligence Preparation of the Battlefield (IPB)
  - Collection Management
    - Collection Requirements Decomposition
    - Collection Tasking
    - Report Evaluation
  - Collection
  - Processing
    - Single Source Correlation
    - Multi-Source Analysis (Fusion)
    - Target Value Analysis
    - Post Attack Assessment
  - Dissemination
    - Combat Information Reporting
    - Intelligence Dissemination
- Electronic Warfare Operations
  - EW Mission Planning and Tasking
  - Electronic Support Measures (ESM) Operations
  - Electronic Counter Measures (ECM) Operations
    - Imitative Electronic Deception (IED)
    - Jamming
  - EW Mission Assessment

The distribution of the TCAE, ASPS and CMDS remains a topic for continued discussion in the IEW doctrinal community. In some field units, the commander augments the CMDS with the CTOC (or DTOC) Support Element as a surveillance oriented control center and remotes the TCAE and EWS separately as a SIGINT/EW oriented control center, rather than aggregating them in an ASAC as shown in Figure 3-3. The IEW model should allow for this kind of flexible employment of these control elements. This discussion, however, follows the FM 34-1 convention of using the ASAC as a centralized IEW control center.

3.3.1.1.3 Military Intelligence (MI) Group (Corps)

The MI Group supporting the corps echelon contains the vast majority of IEW control and action units at corps. Its role is that of a parent unit, supplying administration and logistics support to its components. For this reason, there is no need to explicitly model the MI Group organization, although many of its components will be required in the model. Refer to Figure 3-4 for a description of this unit.

3.3.1.1.4 The Collection Management and Dissemination Section (CMDS)

Collection Requirements Recomposition - The CMDS uses its own staff, and computers supported by those of the ASPS and TCAE to translate approved requirements (PIR or IR) into collectable data elements.[39]

Collection Monitoring - The CMDS uses its own staff and computers to evaluate reported intelligence, in order to determine the validity of the conclusions reached in the situation and target development processes, and to gauge the need for further direction of the tasking process.

Intelligence Dissemination - The CMDS employs its own staff to prepare and distribute several types of intelligence reports to the various commanders in need of the intelligence.

Communications and Movement - The CMDS relies on communications means (multichannel, couriers, RATT) and transportation provided to the ASAC as part of the CTOC.

3.3.1.1.5 Technical Control and Analysis Element (TCAE)

Collection Tasking - The TCAE forms specific collection mission tasking using its organic staff and computers.[39]

Single-Source Correlations - The TCAE employs its staff and computers to validate reported data prior to sending it up the chain to the ASPS for further processing.[39]

Figure 3-3
All Source Analysis Center

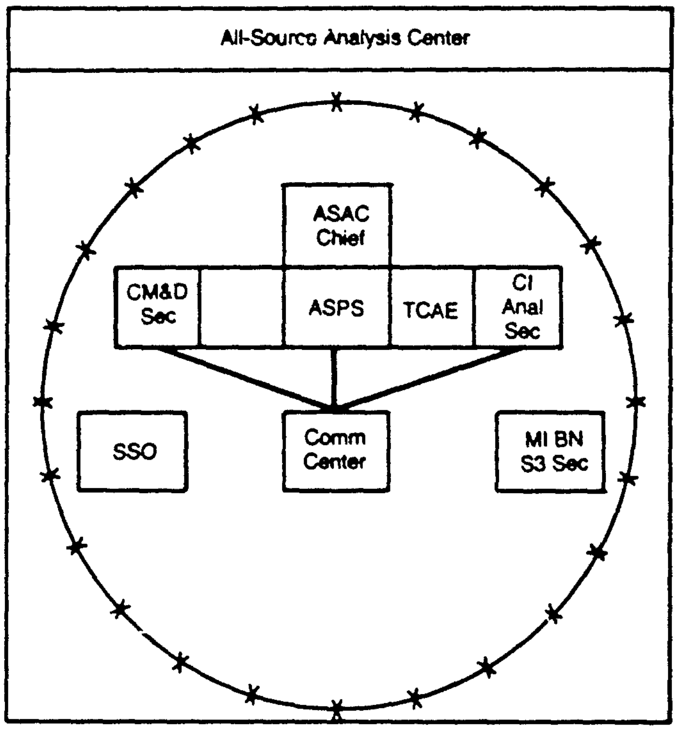
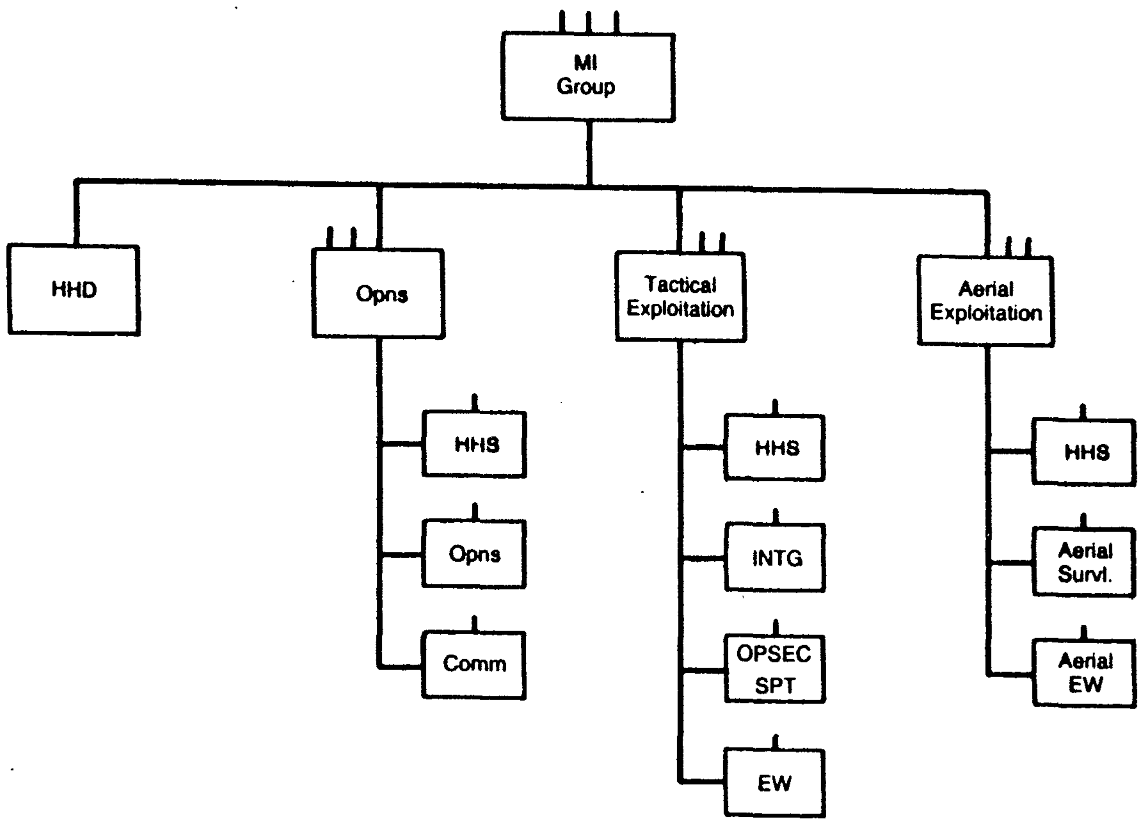


Figure 3-4
MI Group (Corps)



Communications and Movement - The TCAE relies on communications means (multichannel, RATT) and transportation provided to the ASAC as part of the CTOC.

3.3.1.1.6 Tactical Exploitation Battalion (TEB)

The TEB provides enemy prisoner of war (EPW) interrogation, counter-intelligence (CI), and ground-based EW support to the corps. It serves principally as a parent organization, passing collection taskings down from the TCAE to the collection systems, and passing reports back up to the TCAE upon end of mission. It provides administrative and logistical support to its subordinate sensor and jammer systems. For these reasons, it need not be explicitly modeled in an IEW functional area model.

3.3.1.1.7 Aerial Exploitation Battalion (AEB)

The AEB serves as a parent unit for aerial reconnaissance and surveillance sensors, and aerial SIGINT sensors. It provides administrative and logistical support for the airframe-mounted IEW assets in the corps. It does not require the explicit modeling in the IEW functional area model.

3.3.1.2 Action Units

3.3.1.2.1 Corps All Source Production Section (ASPS)

Intelligence Preparation of the Battlefield (IPB) - The ASPS is directly responsible for performing the IPB process at corps, and it uses its own staff, computers and data bases in this effort, along with support from the Corps Engineer for terrain data and from the USAF Weather team at the CTOC for weather data.

Multi-Source Analysis (Fusion) - This unit uses sensor reports of all types along with terrain and weather data to determine enemy location, strength, and intent. It uses its own staff and computer data bases to do detailed correlation and aggregation of the reported data in response to requests from the CMDS.[39]

Target Value Analysis - The ASPS uses its own staff and computers, with support from the Field Artillery Intelligence Officer (FAIO) and Corps Field Artillery Section (FAS) to perform an analysis of proposed targets.[39]

Post Attack Assessment - The ASPS uses its own staff and computers, with support from the FAIO to determine the results of both fire support divisions and EW missions on selected targets.[39]

Communications and Movement - The ASPS is located with the ASAC and relies on the CTOC for communications means (multichannel, RATT, couriers) and transportation.

3.3.1.2.2 Long Range Reconnaissance Patrols (LRRPs)

HUMINT Collection - While the long range reconnaissance mission has no current doctrinal expression, its contribution to the quality of the enemy situation assessment produced by the intelligence functional area is of enough significance to warrant explicit modeling at the corps and division levels. In performing HUMINT collection, LRRP forces scout enemy locations, and harass or destroy enemy elements, if so ordered.

Communications - Long range patrols sent behind the front line of troops (FLOT) to report on the enemy's second echelon elements and flanks use tactical radios for the reporting of intelligence gathered. Due to their deep employment, they are vulnerable to capture and compromise. Because of the distances involved, LRRPs often make use of communications relays to report back to the corps or division CMDS. LRRP reports include not only enemy situation reports, but also action unit reports and coordination of recovery means.

Movement - LRRPs are either airlifted into position or infiltrate into the operations area. They may also be left behind in a retrograde movement. They have no organic vehicles for movement. Once employed, they will relocate from time to time in their reconnaissance effort within a predetermined area which has been coordinated with the corps FAS and designated a restricted fire area. Movement and location will not be reported until coordination of recovery is required.

3.3.1.2.3 SIGINT Sensor Systems

Signals Intelligence Collection - In the collection of signals intelligence (SIGINT) the assets involved consist of both ground based and airborne COMINT and ELINT sensors, ground processing stations and operators, and the sensor platform (truck, APC, helicopter, or fixed wing aircraft).

Communications - SIGINT sensors use the tactical radios mounted on the sensor platform for reporting collection results to the TCAE.

Movement - For movement, ground based systems are mounted on trucks or APCs and airborne systems use both fixed wing and rotary wing aircraft. Other assets include the tactical radios used to direct movement, the fuel required to move, and the crew required to assemble or disassemble the ground based equipment and/or required to fly the aircraft.

3.3.1.2.4 Reconnaissance/Surveillance Sensor Systems

Reconnaissance/Surveillance Collection - The capability for reconnaissance and surveillance (R/S) at the corps level is provided by airborne MTI and imagery sensor systems. The MTI systems are currently side looking airborne radars (SLAR) and the imagery systems include television, photo camera, infrared and synthetic aperture radar (SAR) systems. The assets involved include the aircraft, the on-board collection systems, crew, aircraft fuel, sensor operators, ground processing stations and their operators.

Communications - Piloted airborne R/S systems use tactical radios (voice) and digital data links for communicating collection results to the CMDS. Remotely piloted vehicle (RPV) or unattended aerial vehicle (UAV) systems employ television transmitters to send television images to their control stations, and may also use digital data links. The control stations then use tactical radios, the multichannel system or messengers to report back to the CMDS its collection findings.

Movement - R/S aircraft movement is dependent on the aircraft, crew (except for RPV/UAV) and fuel available. Of particular note is the limitation on the mission duration imposed by the aircraft performance and fuel availability.

3.3.1.2.5 Corps Level Jammer Systems

Jamming - In the jamming of enemy communications and radar frequencies, the jammers under corps direction are currently ground-based. The assets used are the jammer itself and the jammer operator(s).

Imitative Electronic Deception - Corps jammers can be used in imitative electronic deception (IED) operations as directed by the EWS via the TCAE. The assets are again the jammer itself and the jammer operator(s).

Communications - Jamming elements use tactical radios for receiving taskings and for reporting results.

Movement - The movement assets of ground based jammers are the vehicles they are mounted on, the vehicle fuel, and the jammer crew.

3.3.2 Division Echelon

The IEW elements found at division closely parallel those found at corps.(39) For the purposes of the IEW functional area model, a duplicate organizational representation can be used, as long as the equipment in both echelons is appropriately allotted. Table 3-3 lists the units at both corps and division that have parallel functions. The functions detailed for the corps counterparts apply to the division units noted. Figure 3-5 shows the MI Battalion (CEWI) which contains the major IEW elements at division echelon. Compare Figure 3-5 with Figure 3-4 for the MI Group at corps.

3.3.3 Brigade Echelon

3.3.3.1 Control Units

3.3.3.1.1 Brigade Battlefield Information Coordination Center (BICC)

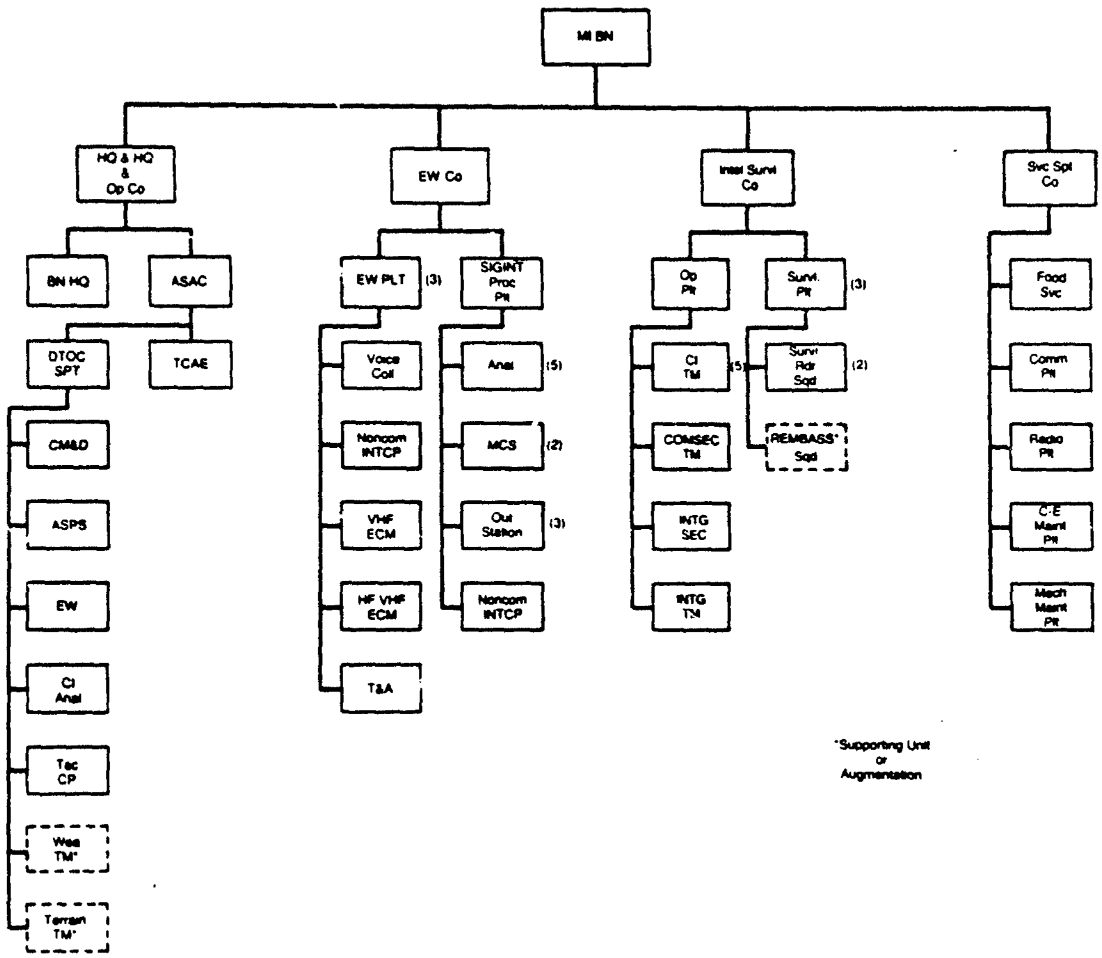
Collection Management - The brigade BICC coordinates with the brigade S3 and the division CMDS for collection management of SIGINT and R/S assets in its area of operations.(39) The assets involved are the brigade S2 staff, the I/EW support element from the CEWI Battalion, the Transcription

Table 3-3

Parallel IEW Elements at Division and Corps

Division	Corps
• control units	• control units
EWS	EWS
ASAC	ASAC
MI Battalion	MI Group
CMDS	CMDS
TCAE	TCAE
EW Co	TEB
Intelligence/Surveillance Co	AEB
• action units	• action units
ASPS	ASPS
LRRPs	LRRPs
SIGINT Sensor Systems	SIGINT Sensor Systems
R/S Sensor Systems	R/S Sensor Systems
Jammer Systems	Jammer Systems

Figure 3-5
MI BN (CEWI) (Division)



and Analysis team from the supporting CEWI BN EW Platoon, tactical radios and t division multichannel system. In addition, the brigade BICC can submit intelligen collection requirements to the brigade S2 for implementation by the subordina maneuver battalions.

Communications - As noted above, the brigade BICC uses tactical radios, tl divisional multichannel system and messengers.

Movement - The brigade BICC staff will displace with the brigade main commai post. This movement of the brigade main CP will not impose a restriction on the BICC operation as a control element.

3.3.3.2 Action Units

3.3.3.2.1 Forward Patrols

Humint Collection - Patrols formed from brigade maneuver elements use vehicle fuel and organic vision devices to detect and identify enemy elements.

Communications - Forward patrols employ tactical radios and messengers fc communications.

Movement - These patrols will move on foot or use whatever transportation is mad available to them according to the mission tasking, which could include jeeps, trucks, o helicopters.

3.3.3.2.2 Remote Sensor Systems (REMS)

Reconnaissance/Surveillance Collection - Remotely monitored sensors (REMS) ar typically used to detect enemy activity in isolated areas or on critical avenues o approach.[6] The assets used include the REMS teams (operators), expendable sensor (acoustic, seismic, magnetic, and strain-cable), relays, monitors, tactical radios, and fue for generators. Most REMS are passive devices and transmit only when activated. High noise levels due to thunder, rain and/or wind may degrade acoustic system abilities tc detect enemy activity.

Communications - REMs automatically send messages back to the monitoring station when activated. They use tactical radios and repeater transmitters for this reporting. The monitoring stations send tactical intelligence reports to tasking authority upon verification of enemy activity.

Movement/Emplacement - Sensors/repeaters are usually emplaced either by field artillery or aviation elements. In a retrograde movement, the REMs teams can emplace the systems by hand.

3.3.3.2.3 Ground Surveillance Radar (GSR) Systems

Reconnaissance/Surveillance Collection - Forward elements of brigade action units (probably the companies) will employ GSRs for area and route reconnaissance and for perimeter defense. These radars are provided by the divisional CEWI Battalion and their use is monitored by the brigade BICC. Designed principally as early warning and perimiter defense observation devices, they are typically not tasked as intelligence collection assets. Occasionally, however, combat information obtained by these forward radars can be utilized by the brigade BICC and/or the division/corps CMDS in the situation or target development processes.[5]

Communications - Forward combat elements using GSRs use tactical radios and messengers for communications.

Movement - The GSRs will move with the forward combat elements, using vehicles and fuel supplied by those elements.

3.3.4 IEW Equipment Representation

The following section describes major IEW sensor, jammer, and processing systems in terms of the major characteristics which should be represented in an IEW model. Each system is described according to its major components (platform, collector jammer, ground station, etc.) and each component is broken down into a set of factors and units appropriate to each factor. Material for this section was provided by references 19 20 and 21. These descriptions are intended to serve as a guide and should not be viewed as restricting model representations of the systems included. The main purpose is to show in this section parametric representations of IEW equipments appropriate to an IEW Functional Area Model.

3.3.4.1 Generic SIGINT System

3.3.4.1.1 Platform Characteristics

Factor	Units
Payload	lb.
Range	km
Time on station	minutes

Max speed	knots or km/n
Operational speed	knots or km/n
Max height	meters
Operational height	meters
Fuel load	lb.
Crew required	n
Survivability index	n
Tracks-Ground systems only	n
Wheels-Ground systems only	n
Type	ground or air
Location	km from FEBA, or x, y, (z)
No. of platforms	n
Vulnerabilities	ADA, weather, etc.
Mean time between failures	hours
Mean time to repair	hours

3.3.4.1.2 Collector Characteristics

Factor	Units
Crew required	n
Frequency range	n .. n MHz
Modulation	AM, FM, CW, SSB, PM (COMINT only)
Sensitivity	db
Location error - range	meters
Location error - azimuth	degrees
DF fix accuracy	meters
Coverage range	km
Sector scan	degrees
Revisit time	seconds
Mean processing time	seconds
Saturation rate	# intercepts/minute
Method of reporting	means
Reporting speed	# reports/minute
Freq. measurement error	MHz
PRF measurement error	sec. (ELINT only)
PW measurement error	sec. (ELINT only)
Frequency hop capability	Y/N (ELINT only)
Pulse stagger capability	Y/N (ELINT only)
Constraints	LOS, distance, etc.
Data link	Y/N, to where
Mean time between failures	hours
Mean time to repair	hours

3.3.4.1.3 Ground Processing Station Characteristics

Factor	Units
Crew required	n
Tether range to platform	km
# collectors at one time	n
Mean processing delay	minutes
Mean communications delay	minutes
Saturation rate	# reports/minute
Location	km from FEBA, or X, Y
Number of receivers	n
Channels per receiver	n
Collectible frequency (each channel)	n .. n MHz

3.3.4.2 Generic Photo Imagery System

3.3.4.2.1 Platform Characteristics

Factor	Units
Range	km
Time on station	min.
Max speed	knots
Operational speed	knots
Max height	meters
Operational height	meters
Fuel load	lb.
Crew required	n
Survivebility index	n
Number of platforms	n
Location	x, y, z
Vulnerabilities	ADA, weather, etc.
Mean time between failures	hours
Mean time to repair	hours

3.3.4.2.2 Collector Characteristics

Factor	Units
Mean process delay	seconds
Data linked	y/n, to where
Number of cameras	n
- obscuration factors	foliage, clouds, light conditions
- min/max look angle	degrees
- area covered/opn. ht.	sq. km
Crew required	n

Collection means	film or electro-optical (if electro-optical, ground station processing delay is 0)
Mean time between failures	hours
Mean time to repair	hours

3.3.4.2.3 Ground Processing Station Characteristics

Factor	Units
Mean process delay	min.
Mean commo delay	min.
Crew required	n
Saturation rate	reports/min.
# collectors at a time	n
Location	km from FEBA, or x, y

3.3.4.3 Generic IR System

3.3.4.3.1 Platform Characteristics

Factor	Units
Range	km
Time on station	min.
Max speed	knots
Operational speed	knots
Max height	meters
Operational height	meters
Fuel load	lbs.
Crew required	n
Survivability index	n
Number of platforms	n
Location	x, y, z
Vulnerabilities	ADA
Mean time between failures	hours
Mean time to repair	hours

3.3.4.3.2 Collector Characteristics

Factor	Units
Mean process delay	seconds
Data linked	Y/N, to where
Number of cameras	n
- Obscuration factor	temperature, emissivity of objects
- Min/max look angle	degrees
Crew required	n
Collection means	film

Mean time between failures	hours
Mean time to repair	hours
Constraints	needs backup photo for verification, requires low flight

3.3.4.3.3 Ground Processing Station Characteristics

Factor	Units
Mean processing delay	min.
Mean commo delay	min.
Crew required	n
Saturation rate	reports/min.
# collectors at a time	n
Location	km from FEBA, or x,y

3.3.4.4 Generic Imaging Radar System

3.3.4.4.1 Platform Characteristics

Factor	Units
Type	air, ground, manpack
Range	km
Time on station	min.
Max speed	knots
Operational speed	knots
Max height	meters
Operational height	meters
Fuel load	lb.
Crew required	n
Survivability index	n
Number of platforms	n
Location	x, y, (z)
Vulnerabilities	ADA, weather, etc.
Mean time between failures	hours
Mean time to repair	hours

3.3.4.4.2 Collector Characteristics

Factor	Units
Type	radar type
Crew required	n
Area covered at operational height	square km
Mean process delay	seconds
Data linked	Y/N, to where
Range at operational height	meters

Angular resolution	degrees
Output	digital display, film
Vulnerabilities	active emitter
Mean time between failures	hours
Mean time to repair	hours

3.3.4.4.3 Ground Processing Station Characteristics

Factor	Units
Mean processing delay	min.
Mean commo delay	min.
Crew required	n
Saturation rate	reports/min.
# collectors at a time	n
Location	km from FEBA, or x, y

3.3.4.5 Generic MTI System

3.3.4.5.1 Platform Characteristics

Factor	Units
Type	air, ground vehicle, manpack
Location	x, y, (z)
Number of platforms	n
Range	km
Time on station	min.
Max speed	knots or km/n
Operational speed	knots or km/n
Max height	meters
Operational height	meters
Fuel load	lbs.
Crew required	n
Survivability index	n
Vulnerabilities	ADA, weather for air
Tracks	n, ground only
Wheels	n, ground only
Mean time between failures	hours
Mean time to repair	hours

3.3.4.5.2 Collector Characteristics

Factor	Units
Target types detected	personnel, vehicles (tracked, wheeled)
Constraints	LOS, etc.

Data linked	Y/N, to where
Velocity threshold/target type	km/n
Crew required	n
Resolution	meters
Mean process delay	seconds
Range resolution	meters
Angular resolution	degrees
Output	digital display, film
Vulnerabilities	active emitter
Mean time between failures	hours
Mean time to repair	hours
Power	watts

3.3.4.5.3 Ground Processing Station Characteristics

Factor	Units
Crew required	n
# collectors at one time	n
Mean processing delay	min.
Mean commo delay	min.
Saturation rate	# reports/min.
Location	km from FEBA, or x, y

3.3.4.6 Generic CM/CB System

3.3.4.6.1 Platform Characteristics

Factor	Units
Number of platforms	n
Location	x, y
Fuel load	lb.
Crew required	n
Survivability index	n
Vulnerabilities	active emitter
Tracks	n
Wheels	n
Mean time between failures	hours
Mean time to repair	hours

3.3.4.6.2 Collector Characteristics

Factor	Units
Frequency range	n .. n MHz
Range resolution	meters
Angular resolution	degrees

Reporting speed	reports per minute
Constraints	limited operator time
Output	real-time target location; hard copy
Mean processing delay	seconds
Target types detected	artillery, mortars
Data linked	Y/N, to where
Vulnerabilities	active emitter
Crew required	n
Mean time between failures	hours
Mean time to repair	hours

3.3.4.6.3 Ground Processing Station Characteristics

Factor	Units
Crew required	n
# collectors at one time	n
Mean processing delay	min.
Mean commo delay	min.
Saturation rate	# reports/min.
Location	km from FEBA, or x, y

3.3.4.7 Generic REMS System

3.3.4.7.1 Collector Characteristics

Factor	Units
Sensing Life	hours
Frequency range	n .. n MHz
Accuracy	emplacement
Data link	Y/N, to where
Range	km
Constraints	emplacement may require penetration of enemy territory
Vulnerabilities	environmental noise, heat, vibrations, etc.
Mean processing time	Seconds
Location	x, y
Output	target locations, number, direction
Saturation rate	# reports/min.

3.3.4.7.2 Monitor Characteristics

Factor	Units
Channels	n
# collectors monitored	n
Location	x, y; or with what unit
Mean processing delay	min.
Mean commo delay	min.
Saturation rate	# reports/min.

3.3.4.8 Generic Jamming System

3.3.4.8.1 Platform Characteristics

Factor	Units
Type	air or ground
Crew required	n
Fuel load	lbs.
Location	x, y
Survivability index	n
Vulnerabilities	AD for air
Tracks	n
Wheels	n
Mean time between failures	hours
Mean time to repair	hours
Max Speed	Knots or km/n
Operational Speed	Knots or km/n

3.3.4.8.2 Jammer Characteristics

Factor	Units
Frequency range	n .. n MHz
Power	Watts
Data link	Y/N, to where
Constraints	frequency limits, to avoid jamming friendly emitters
Vulnerabilities	enemy ECCM
Location	x, y
Output	FM, CW, AM, SSB, PM
Mean time between failures	hours
Mean time to repair	hours

3.4 Other Functional Areas

This section discusses the interfaces with functional areas other than IEW, and modeling needs in areas of particular concern to an IEW Model.

3.4.1 Maneuver Control

The principal interfaces between IEW and maneuver control (composed of the combat and combat support subfunctional areas) are the integration of intelligence provided through combat units, and communications and engineer support for IEW forces.

In general, maneuver elements are not specifically tasked as IEW elements are in the collection process, with two major exceptions. First of all, cavalry elements at corps and division have primary functions relating to reconnaissance and surveillance and do in fact receive detailed collection taskings through the G2/S2 channels. The use of air cavalry units in particular is oriented towards intelligence collection for the commander. The second exception is the corps and division engineer elements whose secondary role is to report terrain data relevant to collection taskings from the G2 of their parent echelon. Again, specific collection taskings can take place for collection of detailed information on terrain items which have direct impacts on enemy location and maneuver. In both cases of the cavalry and engineer elements, the unit S2's perform a similar role to that of the maneuver brigade BICC described in section 3.3.3.

For units not specifically tasked as intelligence collectors, a linkage must still be provided to allow combat information relating to known PIR/IR to be reported through the unit S2 to the parent echelon G2/S2 for assimilation into the situation development process.

Communications support, in the form of provision of backup communications channels, will be required of the maneuver control functional area by IEW elements. Specific study issues exist to examine the IEW communications capabilities, including the backup capability resident in the maneuver forces. These channels must be explicitly represented.

Engineer support is required for mobility and survivability support to IEW elements. During adverse weather conditions IEW elements can request mobility assistance from engineer elements, including bridge emplacement and road clearing.

Survivability support relates to the ability to maintain operations under enemy attack. To this end, engineer elements may be needed to erect mobility barriers and shelters to aid in the protection of sensitive IEW systems.

3.4.2 Fire Support (FS)

IEW linkages to fire support fall in two major areas, target development and USAF R/S support. The ASPS at corps and division is complemented with both IEW and FS personnel. The process of target development begins and ends at the ASPS insofar as the IEW elements are concerned, but in order to reflect the impact of target detection on the battle, a quickfire link to the Corps FAS and Division FSE is required to cue fire support assets to attack and destroy these targets. The rapid integration of FS target acquisition successes into the situation and target development processes hinges on the use of the Field Artillery Intelligence Officer resident at the ASAC. He acts as a liaison between FS elements and the CMDS and ASPS and such a linkage must be included in an IEW model.

3.4.3 Air Defense Artillery (ADA)

The primary linkage between IEW and ADA of importance to the IEW Model is the coordination of passage of IEW assets through airspace controlled by ADA elements. Corps and division level airborne sensors/jammers require route coordination during both the deployment and employment phases of a mission, in order to avoid being attacked by friendly ADA forces.

3.4.4 Combat Service Support

The requirements research has not discovered any IEW linkages in this area currently in need of highlighting. The CORDIVEM CSS functional area representation objective (FARO)[11] is sufficiently detailed for use in the IEW model.

3.5 Threat Representation

The IEW Functional Area Model is planned to share a common threat representation with the generic CORDIVEM[14]. Because of the nature of the analyses to be employed in the IEW Model, however, certain augmentations may be required to provide the paramatric sensor representations with observables to collect. These observables consist of two basic components: physical objects relating to threat units and their equipments, and activity patterns reflective of threat unit behaviors. Each is discussed below.

3.5.1 Threat Units and Equipments

In general, the level of resolution of threat used in the generic CORDIVEM is battalion level, with non-maneuver units represented at a lower level when they are employed as company and even platoon elements. The IEW functional area model will require a greater degree of resolution. While a detailed propagation-level representation is not necessary, the parametric sensor models will be looking for components of company-sized units (vehicles, radios, radars, bunkers, etc). Unit templates based on equipment configurations used in sensor data processing require lower than battalion resolution. This, however, is not a fixed requirement. As analytical needs change, the model will need to vary the resolution of threat units and equipment represented to fit the study. At this level, however, the company level is the lowest maneuver echelon required for the IEW Functional Area Model.

3.5.2 Threat Behaviors

Emission, movement and shooting events take on additional meanings when viewed in the battle context. Behavior patterns often reflect enemy intentions in manners that equipment configurations don't. The IEW model requires a flexible rule-base for the modeling of Red force C^3 and the implementation of decisions in force movement, communications and shooting. The model must be able to allow improvements in threat decision-making over time as commanders gain battle experience. In a similar fashion, threat units must be able to change emission patterns when previous patterns are easily detected and subject to attack. In short, the threat needs to exhibit the same type of adaptibility a real threat will on the battlefield. In an IEW Model this flexibility is very important since the job of situation development processes is to detect enemy behavior patterns and changes in those patterns in order to deduce enemy intent.

4.0 DESCRIPTION OF REQUIRED IEW PROCESSES

This section will describe each of the capabilities introduced in Section 3 for IEW elements. Each capability will be delineated with regard to the events which trigger its execution, the internal process involved, and the output it provides. Included with each process are the IEW elements that perform the process (see Section 3.3).

For the IEW functional area model, the major capabilities for all functional areas except IEW will remain as defined for CORDIVEM,[11] the IEW capabilities being more detailed in terms of their major functional area disciplines[13]. Table 4-1 relates these expanded IEW capabilities to the general categories of functions considered in the CORDIVEM IEW FARO.[11]

TABLE 4-1

IEW MODEL PROCESSES AND CORDIVEM

IEW	CORDIVEM
• Situation Development and Target Development	
- IPB	
- Collection Management	Collection Mission Management
— Collection Requirements	Decomposition n/a*
— Collection Tasking	Collection Mission Management
— Collection Monitoring	Collection Mission Management
- Collection	
- Processing	
— Single-Source Correlation	n/a
— Multi-Source Analysis (Fusion)	Fusion
— Target Value Analysis (TVA)	n/a
— Post Attack Assessment	n/a
- Dissemination	Communications
• EW Operations	
- EW Mission Planning and Tasking	Jamming Mission Management
- ESM Operations	Collection
- ECM Operations	Jamming
— Imitative Electronic Deception (IED)	n/a
— Jamming	Jamming
- EW Mission Assessment	n/a
• Movement	movement
• Communications	communications

* n/a = not addressed or not applicable to the CORDIVEM scope.

4.1 Situation and Target Development

4.1.1 Intelligence Preparation of the Battlefield (IPB) (Corps and Division ASPS)

- Input. IPB requires four major types of data. Doctrinal threat templates are provided by the G2 staff and the ASPS. Identification of the Area of Interest/Influence (AII) is provided by the force commander, delineating the geographic area of concern. Terrain data supplied by the Corps (or Division) Engineer includes not only topographical information, but also updates as to man-made obstacles, buildings, bridges, etc. which influence force movement and intervisibility. Weather data is provided and maintained by the USAF Weather Team at corps (and division).[39,7]
- Process. IPB is a five-fold process. Step 1 involves determining the probable threat configuration through the use of doctrinal templates which portray threat units in various combat states. The appropriate templates are chosen and adapted if required to reflect the perceived current situation. Step 2 requires the isolation of the AII and the determination of key features within that area to be examined in terrain and weather terms. In step 3, the terrain analysis, the AII is annotated on a map with highlights relating to the impact of the various terrain features present on force movement. Mobility corridors are isolated, and intervisiblity areas are plotted. The weather analysis (step 4) is a refinement of the terrain analysis with expected weather effects on the terrain features. Excessive rain will cause swelling of rivers and streams which can reduce the number of mobility corridors available to the enemy. The final step in IPB is to form the Event and Decision Support Templates which serve as a graphical intelligence estimate and mini-operations plan. Key terrain, weather and enemy operational considerations are highlighted on map overlays to help the force commander make

decisions concerning force maneuver during the battle. They also serve to cue collection management efforts by helping the force commander/G3 staff form relevant and answerable PIR/IR.(39)

- Output. Event and Decision Support Templates are passed to the force commander/G3 Staff for use in formulating force movement decisions and to help in the generation of relevant PIR/IR to drive the collection management process. Event and Decision Support Templates are also passed to the CMDS, ASPS and EWS to help establish collection priorities, to cue processing to look for activity in those areas in which the enemy is most likely to operate, and to cue EW missions against electronic high value targets (HVT), respectively.

4.1.2 Collection Management

Collection Management is a cyclical process composed of the determination of intelligence requirements, the formation of collection taskings, and the evaluation of collection reporting. These functions are described below:

4.1.2.1 Collection Requirements Decomposition. (Corps and Division CMDS)

- Input. The collection requirements definition phase is triggered by requests from the force control elements for answers to the PIR/IR. In the IEW model, the PIR/IR flow down from force control and must be decomposed into recognizable data items which can be gathered by the IEW collection systems. In a similar manner, high value targets (HVT) are received from the EWS and ASPS and are decomposed into collectable data items.(39) The results from the IPB process are received from the Corps ASPS.
- Process. The PIR/IR are broken down into the critical indicators, and critical indicators into data elements that can be collected. For example, the PIR posed as "Will the enemy attack in the south, and if so, when?" would be decomposed into the critical indicators of an attack for the situation at hand. Since a critical indicator of an

attack is the forward displacement of artillery units, the resulting data elements required to answer the PIR would be:

- Number of artillery units in the southern sector
- Location of movement, and speed
- Some criteria for establishing that they are "forward"
- An estimate of when that state will be achieved

- Output. The result of this process is a list of collection requirements at the data element level keyed to the PIR/IR/HVT which sparked the process. These requirements are given to the collection management element.

4.1.2.2 Collection Tasking (Corps and Division TCAE)

- Input. As noted above, the receipt of required PIR/IR and HVT data elements will trigger collection tasking.
- Process. Collection tasking begins with the searching of established databases to determine if the required data items are readily available. If not, a review of the current tasking of appropriate sensor systems is made to determine if the data elements can first be gained from established missions, or second, if current missions can be expanded to gather the additional information. If current missions are inadequate, new missions are specified. Priorities are then set for collection missions and missions are added or cancelled as needed to insure responsive collection.
- Output. The output from the collection tasking phase is a mission directive sent to the collection system which would include the specific collection parameters required in order to gather the data elements sought. To continue the example of the PIR/IR relating to an attack in the south, a collection tasking might be as follows:

  Sensor: Aerial R/S airframe #1068
  Station: Oval reconnaissance bounding (position x to position y)
  Time: 0430-0500 hrs 14 MAR 79
  Configuration: SLAR/PHOTO
  Resolution: 5X

Data elements required: company and larger movements south out of assembly areas in vicinity of highway 23, 48 and 15.

Requirement #: 12810 (division)

4.1.2.3 Collection Monitoring (Corps and Division CMDS)

- Input. The ASPS sends the CMDS interim reports concerning the availability and applicability of reported intelligence to the stated PIR/IR/HVT and critical indicators of enemy activity. The TCAE will also report on the availability and appropriateness of certain sensor systems with regard to selected collection requirements.[39]
- Process. The CMDS is responsible for determining whether further decomposition or definition of the PIR/IR/HVT is required, whether further or more specific collection taskings are required, whether clearer guidelines are needed for processing, etc., in order to satisfy PIR/IR/HVT in a timely manner.
- Output. The CMDS will, as a result of collection monitoring, clarify, restate or redefine intelligence requirements, collection tasking instructions and/or processing guidelines as required to aid in the answering of the PIR/IR/HVT.

4.1.3 Collection (all collection systems)

- Input. Collection begins with a tasking directing a sensor system to deploy to an area and operate its collection means in a particular fashion to obtain and report specific data elements required to answer the PIR/IR/HVT.
- Process. Upon receipt of a mission, a sensor will deploy to the operational station and begin sensing during the time span indicated in the collection order. If the mission is unsuccessful during the specified timeframe the mission can be redirected or continued, subject to the tasking authority. Upon receipt of the required data, the sensor assembles the data for transmission to the processing facility involved, if required, or directly to the tasking authority if little or no processing is involved.

- Output. Collected data is reported to the tasking authority along with a current status report.

4.1.4 Processing

IEW processing is performed at three levels, at the sensor or ground processing station level, at the tasking authority level (TCAE), and at the multi-source and target-value analysis level (ASPS). For purposes relating to an IEW functional area model, the first level of processing is considered to be an internal process to the collection system and is not described here. That level is more relevant to a process model which seeks to represent sensor collection algorithms in detail. The other two levels are detailed here:

4.1.4.1 Single-Source Correlation (Corps and Division TCAE)

- Input. Critical indicators and data items from the PIR/IR/HVT decomposition are received from the CMDS. Formatted tactical intelligence reports are received from sensors of like types. Maintenance and performance histories of sensor systems are maintained by the TCAE.
- Process. Reported data elements are reviewed for consistency and validity, and are checked against known sensor error characteristics. Data from individual sensors is compared with that from other sensors tasked in the same area to determine overlaps and/or confirmations. PIR/IR filled at this level are tagged for reporting to the collection management authority (CMDS).
- Output. Fulfilled PIR/IR are sent to the CMDS. Collected and/or corrected data is forwarded to the ASPS for further processing. Satisfied HVT are passed to the Corps FAS (or the Corps EWS for electronic HVT) for targeting.

4.1.4.2 Multi-Source Analysis (Fusion) (Corps and Division ASPS)

- Input. Tactical intelligence reports from the single-source correlation phase, weather reports, and critical indicators formed through requirements decomposition effort are tagged to unfulfilled PIR/IR/HVT.

- Process. Data elements gathered from various sources are time ordered and then overlaid. Cross function evaluations are performed to eliminate obvious errors, reliability factoring is done to assess relative confidence levels, and critical indicators are either satisfied or not, depending on the success of the collection effort. Targeting requirements are also reviewed for those targets not found with single-source methods.
- Output. Satisfied PIR/IR/HVT are assembled for dissemination to the force commander and his staff. Unsatisfied PIR/IR/HVT are evaluated to see if they require further collection, or if they can be removed from the cycle if no longer required.

4.1.4.3 Target-Value Analysis (TVA) (Corps and Division ASPS)

- Input. The Event and Decision Support Templates from the IPB process form the basis for TVA, along with the enemy order of battle perception (OB) as it develops in the ASPS.
- Process. Weather and terrain data used in the IPB process are related to the doctrinal templates for the opposing force, with an eye to determining critical points of enemy weakness. For instance, enemy operations in a marshy area during wet or cold weather conditions require sustained combat engineer support for mobility. Isolation of enemy combat engineers and their neutralization can significantly aid in countering the opposing force's mobility. In this way, TVA evaluates the enemy OB against known weather and terrain factors to determine high value targets.[39]
- Output. Collection requirements recommendations (for target development) are passed to the CMDS in the form of a target list. Reported target detections are passed to the Corps FAS, Division FSE or Corps EWS for engagement.

4.1.4.4 Post Attack Assessment (Corps and Division ASPS)

- Input. EW end of mission reports and tactical sensor reports are received from the TCAE. Fire support end-of-mission reports are passed to the ASPS from the Corps FAS or the Division FSE. The target list formed in TVA is also used in post attack assessments.

- Process. As a result of the TVA and collection efforts, fire support and/or EW assets have attacked the identified high value target. Included in the end-of-mission report is information relating to the success of the attack. At the same time, IEW collection systems may have independently observed the results of the attack. Confirmation is made of the destruction/degradation/disruption of enemy HVT and an estimation of the damage done to enemy operations is made. Recommendations for exploiting the damage are formed.[39]
- Output. The damage assessment and recommendation for further action is forwarded to the CMDS for dissemination to the force commanders/G3 staffs involved.

4.1.5 Intelligence Dissemination (Corps and Division CMDS)

- Input. Satisfied PIR/IR with supporting critical indicators and data elements are received from the fusion center (ASPS) or the single source analytical centers (TCAE).
- Process. Completed PIR/IRs are gathered by function, relating to the force's mission, and are assembled into intelligence summaries (INTSUMS) for the force commander's review. If transmission to a lower or higher echelon is required, a communications means is selected.
- Output. Intelligence summaries are presented to the force commander on a predetermined basis, depending on the pace of the battle, or on demand.

4.2 EW Operations

Electronic Warfare (EW) consists of intelligence collection relating to the enemy signals environment (ESM), countermeasures designed either to deceive or disrupt the enemy (ECM), and countermeasures to the enemy's attempts to deceive or disrupt friendly forces (ECCM). EW is the responsibility of the G3 staff, as electronic warfare systems are considered as weapons and not as collection systems. Even so, substantial IEW efforts are required in ESM, ECM and ECCM to implement the G3's direction. ECCM is

not discussed here, as it principally consists of a set of policies regarding signals security and is not appropriately modeled in an IEW functional area model.

4.2.1 EW Mission Planning (Corps and Division EWS)

- Input. The G3 staff gives the EWS a detailed summary of the commander's concept of operations, focusing on the desired method of attack of high value targets (HVT). The Corps FAS (Division FSE) provides input from the fire support channels to help form an integrated HVT attack plan. The results of the IPB process are used as well to cue EW plans.
- Process. Templates are used to focus ESM collection on identified HVT and to determine defensive EW measures to defeat enemy counter-C^3 efforts.[39] Electronic HVT are divided into four major groups:
    - HVT to be destroyed
    - HVT to be jammed
    - HVT to be intercepted for intelligence collection purposes
    - HVT to be deceived

Appropriate attack strategies are outlined for each group of targets, and attack means are identified. Combinations of fire support and EW attacks are coordinated at this level. Those HVT requiring EW attack are prioritized with the following priorities:

- protection of friendly C^3 systems
- attack of enemy direct and indirect fire forces
- suppression of enemy air defense forces (SEAD)
- countering enemy C^3 (C^3CM)

- Output. ESM collection priorities (electronic HVT's) are sent to the CMDS for inclusion in the collection requirements decomposition process. Mission taskings are formulated for EW assets and passed to the intermediate tasking authorities for implementation.

4.2.2 ESM Operations (SIGINT sensor systems)

Electronic Warfare Support Measures (ESM) Operations involve the intercept and direction finding activities of SIGINT sensor systems designed to detect and locate enemy electonic HVT. These operations are contained within the collection process identified for Situation and Target Development (Section 4.1.3).

4.2.3 ECM Operations (Corps and Division Jammer Systems)

Electronic Countermeasures involve two major sub-processes, imitative electronic deception (IED) and jamming.[39] Jamming systems are capable of performing both of these functions, although specific types of IED may require highly specialized equipment and operators.

4.2.3.1 Imitative Electronic Deception (IED) (Corps and Division Jammer Systems)

- Input. Mission taskings come from the EWS via the appropriate intermediate headquarters. Mission tasking includes target description, method of deception to be employed, message to be passed or nuisance type to be injected into enemy communications channels, etc.
- Process. IED may involve actually entering the enemy radio nets as a bona fide net member and the passing of false information to the enemy. Another form of IEW involves the use of enemy-like communications as a nuisance to enemy nets or communications centers. Open or encoded information can also be used to allow the enemy to think he has intercepted and broken into a valuable source of information about the friendly forces. Finally, jamming can be used to deceive the enemy at key junctures regarding friendly intentions.[39]
- Output. In most cases, false information is passed to the enemy to become the basis for decisions that will ultimately serve to degrade enemy operations.

4.2.3.2 Jamming (Corps and Division Jammer Systems)

- Input. Mission taskings come from the EWS via the appropriate intermediate headquarters.
- Process. The jamming system may or may not need to displace upon receipt of a mission order, but the system will bring itself within range and in electronic line-of-sight of the target. The jamming is executed according to the specific parameters received in the mission orders which include frequency, signal strength, target location, attack strategy, and duration of the jamming mission. If a look-through capability is present, the jammer will determine the effect of the mission (duration of interrupted enemy activity), and report this to the tasking authority.
- Output. An end of mission report is passed to the tasking authority (EWS) upon completion.

4.2.4 EW Mission Assessment (Corps and Division EWS)

- Input. End-of-mission reports from jammer systems are passed to the EWS to aid in the determination of success in the electronic attack of HVT. Enemy order of battle (OB) data are received from the ASPS.[39]
- Process. Reported mission results are compared to the enemy OB and confirming intelligence reports regarding particular HVT to determine the impact on enemy forces. The damage from electronic attack is particularly difficult to assess unless it results in an altered behavior which can be observed with other sensor systems.
- Output. The EWS refines its attack priorities for electronic HVT as attacks are executed, confirmed and assessed. In this way EW support to the commander is kept timely and responsive.

5.0 REQUIREMENTS ANALYSIS AND RECOMMENDATIONS

Table 5-1 portrays the major characteristics of the various application requirements drawn from the user requirements presented in Section 2. By reviewing this table it is apparent that one model cannot support the full range of requirements summarized therein. This section presents a method of satisfying these requirements with a group of IEW models consistent with one another and the AMIP hierarchy of models.

The following paragraphs will relate each of the application areas to the identified requirements categories as shown in Table 5-1.

5.1 Combat Force Representation Requirements

Each of the three analytical applications require a fully two-sided combat model with resolution which varies from battalion level (MAA, CORDIVEM) down to company and equipment level (COEA). The system testing applications do not require a combat model at all, since their primary functions are to test hardware and software under varying conditions which can be produced artificially (without a combat model) without prejudicing the results. The two training applications differ in this need. Field training and command post exercise (FTX/CPX) support certainly requires a full representation of both Blue and Red combat and C^3 elements. School training needs center on Blue IEW organizational and procedural instruction, and studies of Red combat force behavior. These do not require a full representation of Blue combat forces to maintain training utility.

5.2 Blue Functional Area Representation Requirements

The analytical applications require a balanced representation of all five functional areas to maintain analytical integrity. The system test and training needs can be satisfied by detailed IEW representations omitting much, if not all, of the rest of the Blue force.

5.3 Speed Requirements

In every application area, the proponents either identified a need for faster than real time simulation support or would settle for real time processing. It is unclear the degree to which this factor can be used for a requirements analysis, but in general it can be said that the stochastic

TABLE 5-1

MODEL CHARACTERISTICS BY APPLICATION AREA

CHARACTERISTICS	ANALYSIS MAA	ANALYSIS COEA	ANALYSIS CORDIVEM	SYSTEM TEST DEVELOP.	SYSTEM TEST CDSF	TRAINING CPX/FTX	TRAINING SCHOOL
BLUE Combat Representation	X	X	X	N/R	N/R	X	N/R
Functional Areas	S	S	S	IEW	IEW	IEW	IEW
RED Combat Representation	X	X	X	X	X	X	X
Speed	FTRT	FTRT	FTRT	FTRT/RT	N/I	FTRT/RT	FTRT/RT
Graphics	N/I	N/I	N/I	N/I	N/I	Interactive	Interactive
Outputs	EVENTS MOE	EVENTS MOE	EVENTS MOE	MOE	MOE	EVENTS	EVENTS
Interaction	Low	Low	Low	Low	Low	High	High
Sensor Representation	Medium	High	Low	High	High	Medium	Medium

Key

X = required
N/R = not required
S = all five functional areas required
IEW = only IEW functional area required
FTRT = faster than real time
RT = real time
N/I = not identified
EVENTS = detailed event history
MOE = tracking selected MOE's

analytical applications have a need to execute many iterations of the model 'overnight' in order to gather a large enough sample for statistical reliability of the results. Deterministic analytical models also have a need, usually due to their size and complexity, to run at a high speed for ease of use during analyses. System test applications in general can take longer for their results, but since the tasks are fewer to begin with, the speed issue is not as critical. Trainers need at least real-time processing to simulate an ongoing battle and to give the students a sense of realism in the battle play.

5.4 Computer Graphics Support Requirements

Only in the training applications were requirements for graphics support clearly identified, although in every application area graphics can play an important role in tracing events and evaluation of the results. For training, however, interactive graphics devices are required to allow the student to converse with the simulation based on the set of knowledge available at different points in the situation. Graphics allow for quick assimilation of large amounts of information, a feature essential in the training of IEW processes.

5.5 Output Requirements

Table 5-1 addresses event histories and MOE traces as outputs applicable to the various application areas. Event history indicates a detailed listing of exactly what transpired (in a military sense) during the simulation run. This includes Blue force movement and engagement, Blue C^3 decisions and the supporting data relevant to each decision, and threat events. MOE trace relates to the tracking of pre-determined measures of effectiveness during the course of a simulation. These apply in all areas but training.

5.6 Degree of Interaction Required

The analytical and system test applications can be thought of as batch processes. Data relating to study issues are prepared in advance, entered into the simulation, and then executed at high speed for many iterations. Typically, no interaction is allowed during execution. Training needs, on the

other hand, require a high degree of interaction to allow students to learn as the simulation proceeds, changing Blue responses to Red behaviors, or intervening in emerging battle outcomes.

5.7 Blue Sensor Representation Resolution Requirements

In table 5-1 three values are listed for this entry. 'Low' relates to a numerical representation of the impact of the use of particular sensor systems. At this level sensor detections can be a matter of a yes/no random generation process. 'Medium' relates to a parametric representation of sensor systems where the sensor performance factors are flexible parameters that can be set by the user to portray several sensors in many configurations and levels of quality. 'High' means sensor systems are represented fully including a full representation of the signal propagation and detection processes. In this representation, the internals of a particular system are modeled.

Due to the nature of the system test and COEA examinations, a high degree of sensor representation is required for those systems under review. The MAA application and the school and CPX/FTX training applications can be satisfied with a medium level (parametric) representation with the sensor performance parameters being supplied off-line from an engineering or process model. The CORDIVEM requires only the results of sensor performance as inputs, thereby meriting the label 'low'.

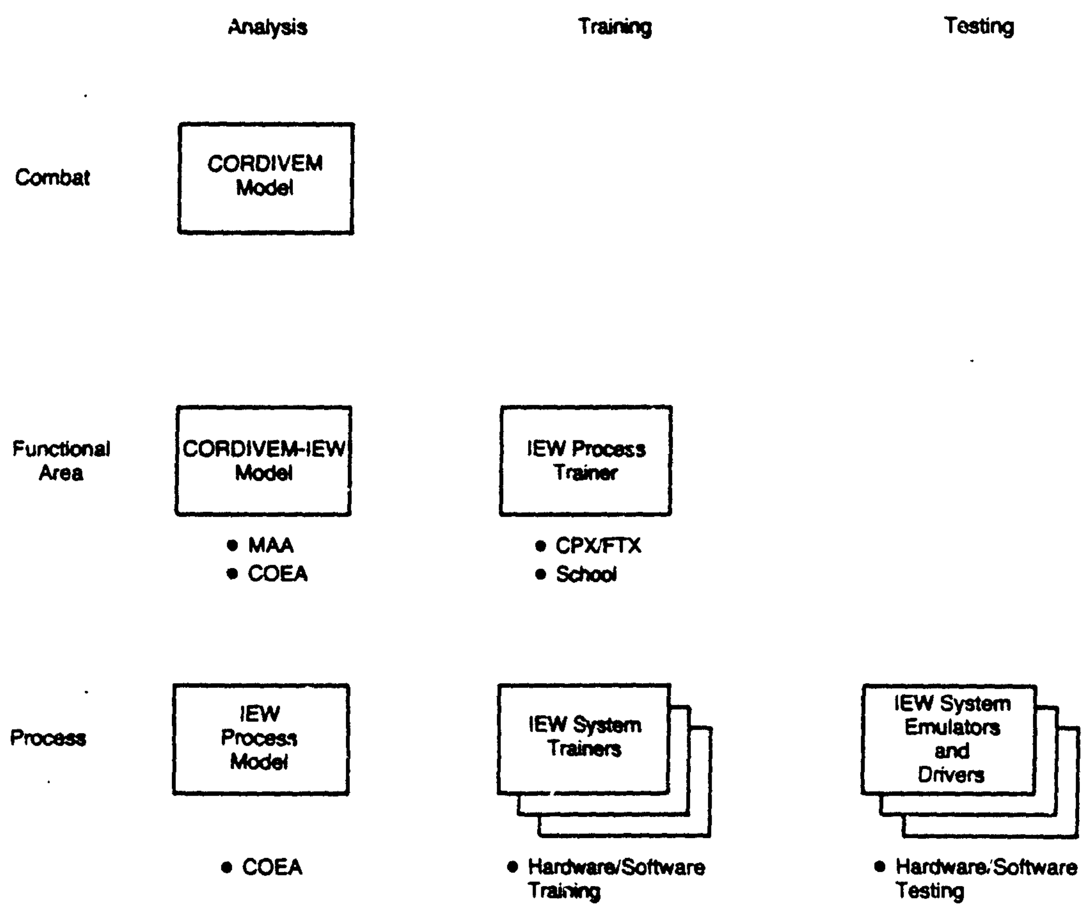
5.8 Recommendations Regarding IEW Model Developments

Figure 5-1 is a layout of the hierarchy of IEW models applicable to the requirements examined in this paper. There are three basic levels of modeling efforts: the process-level models, the functional-level models and the combat-level models. Each level is discussed below.

5.8.1 The Process Level

At this level the focus is on detailed IEW system and process representation. Training of IEW system operators through the use of IEW system simulators and trainers is not considered a candidate for standardization; therefore, such simulators and trainers were not examined in this paper. In a similar manner, models built to emulate specific systems for testing purposes are considered unique developments, and are not good

Figure 5-1
A Hierarchy of IEW Models



candidates for standardization. The IEW Process Model to be employed for detailed IEW analyses is in development at TRASANA. The requirements indicate the need for such a model to perform COEA-type examinations where a high degree of system representation is required.

5.8.2 The Functional Level

Two application areas, analytical and training, have requirements at this level, focusing on process and organizational representations.

In the analytical areas, the CORDIVEM-based IEW Functional Area Model is not currently in development, depending as it does on further decisions regarding the CORDIVEM development. This model, however, is the one to perform MAA evaluations and cross-functional area or cross-echelon COEA evaluations.

In the training area, IEW processes and organizations can be taught with a dedicated traineing system of medium resolution. The TACSIM model under development and in use at TCATA is applicable here. Since the TACSIM model can vary its resolution to fit the training requirements as they emerge, school training proponents should examine the TACSIM model closely for application to their needs. Due to the high degree of resolution required for the IEW Process Model, it is not recommended that the IEW Process Model be used or adapted for traineing purposes.

5.8.3 The Combat Level

At the combat level, the generic CORDIVEM stands alone for support to IEW analysis. The CORDIVEM model must be used in tandem with the IEW Functional Area Model to satisfy some MAA issues, particularly those relating to force effectiveness and corps level IEW systems and interfaces. At the date of this writing, however, there are no identified requirements concerning the types of data required by CORDIVEM from the IEW Functional Area Model. This is primarily due to the lack of a coherent design for the

CORDIVEM development itself. General requirements remain to maintain a common CORDIVEM IEW threat and scenario, model architecture and entity/process representation for non-IEW areas.[13] It is clear that functional area model developments as a whole, including IEW, will have to wait for a settled design for the hierarchical model structures (CORDIVEM, FORCEM, CASTFOREM) before significant design work can proceed.

GLOSSARY

ACSI	Assistant Chief of Staff for Intelligence
AEB	Aerial Exploitation Battalion
AII	Area of Interest/Influence
AM	Amplitude Modulation
AMIP	Army Model Improvement Program
AMMO	AMIP Management Office
ASAS	All Source Analysis System
ASPS	All Source Production Section
BICC	Battlefield Information Coordination Center
BETA	Battlefield Exploitation and Target Acquisition
BN	Battalion
CAORA	Combined Arms Operations Research Activity
CASTFOREM	Combined Arms and Support Task Force Evaluation Model
C^3	Command, Control and Communications
C^3CM	Command, Control, Communications Countermeasures
CCS^2	Command and Control Subordinate Subsystem
CDSF	Combat Developments Support Facility
CEOI	Communications Electronic Operational Instruction
CEWI	Combat Electronic Warfare Intelligence
CI	Counterintelligence
CM/CB	Counter-mortar/Counter-battery
CMDS	Collection Management and Dissemination Section
Co	Company
COEA	Cost and Operational Effectiveness Analysis
COMINT	Communications Intelligence
COMSEC	Communications Security
CORDIVEM	Corps/Division Evaluation Model
CP	Command Post
CPX	Command Post Exercise
CSS	Combat Service Support
CTOC	Corps Tactical Operations Center
CW	Continuous Wave
DARCOM	Development and Research Command
DF	Direction Finding
DT	Developmental Testing
DTOC	Division Tactical Operations Center
EAC	Echelons Above Corps
ECB	Echelons Corps and below
ECM	Electronic Countermeasures
ECCM	Electronic Counter Countermeasures
ELINT	Electronic Intelligence

GLOSSARY

(Continued)

EMP	Electromagnetic Pulse
EOB	Electronic Order of Battle
EPW	Enemy Prisoners of War
ESM	Electronic Support Measures
EW	Electronic Warfare
EWS	Electronic Warfare Section
FAS	Field Artillery Section
FAIO	Field Artillery Intelligence Officer
FEBA	Forward Edge of the Battle Area
FLOT	Front line of Troops
FM	Frequency Modulation
FORCEM	Force Evaluation Model
FSE	Fire Support Element
FTX	Field Training Exercise
G2	Intelligence Staff (Corps, Division)
G3	Operations Staff (Corps, Division)
GSR	Ground Surveillance Radar
GUARDRAIL	Airborne COMINT System
HUMINT	Human Intelligence
HVT	High Value Target
IED	Imitative Electronic Deception
IEW	Intelligence Electronic Warfare
II	Imagery Interpretation
IMINT	Imagery Intelligence
INTREP	intelligence report
INTSUM	Intelligence summary
IPB	Intelligence Preparation of the Battlefield
IR	Information Requirements
JINTACCS	Joint Interoperability of Tactical Command and Control Systems
JTFPMO	Joint Tactical Fusion Program Management Office
LOS	Line-of-Sight
LRRP	Long Range Reconnaissance Patrol
MAA	Mission Area Analysis
MC	Mobility Corridor
M/C	Multichannel

GLOSSARY
(Concluded)

MI	Military Intelligence
MOE	Measure of Effectiveness
MOHAWK	OV-1D Fixed Wing Aircraft
MOP	Measure of Performance
MTI	Moving Target Indicators
NAI	Named Area of Interest
OB	Order of Battle
OMG	Operational Maneuver Group
OPSEC	Operations Security
QUICKFIX	Airborne Comint/Jamming System
QUICKLOOK	Airborne Elint System
OV-1D	Army Fixed-Wing Surveillance Aircraft
OT	Operational Testing
PIR	Priority Intelligence Requirements
PM	Pulse Modulation
RAP	Rear Area Protection
RATT	Radio Teletypewriter
R/S	Reconnaissance/Surveillance
RCE	Residual Combat Effectiveness
REMS	Remotely Monitored Sensors
RPV	Remotely Piloted Vehicle
S2	Intelligence Staff (brigade, battalion)
S3	Operations Staff (brigade, battalion)
SAR	Synthetic Aperture Radar
SEAD	Suppression of Enemy Air Defense
SIGINT	Signals Intelligence (COMINT and ELINT)
SLAR	Side Looking Airborne Radar
SSB	Single Sideband
TACSIM	Tactical Simulator
TCAE	Technical Control and Analysis Element
TCATA	TRADOC Combined Arms Test Activity
TEB	Tactical Exploitation Battalion
TRAILBLAZER	Ground-based COMINT System
TRASANA	TRADOC Systems Analysis Activity
TRADOC	Training and Doctrine Command
TVA	Target Value Analysis
UAV	Unattended Aerial Vehicle
USAICS	U.S. Army Intelligence Center and School
WX	Weather

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